

DRAINAGE STUDY

For

SPITSBERGEN RESIDENCE DRIVEWAY

2857 Southern Oak Road

GRADING PERMIT NO. L-14522

LOG NO. 02-14-042

January 2004
Revised 05/18/04
Revised 01/04/05
Revised 03/13/07

Prepared For:

Mark P. Spitsbergen
2857 Southern Oak Road
Ramona, California 92065

and

The County of San Diego
Department of Public Works
5201 Ruffin Road
San Diego, California 92123

By

Nasland Engineering
4740 Ruffner Street
San Diego, California 92111
(858) 292-7770
(858) 571-3241(Fax)
NE No. 103-214.1

TABLE OF CONTENTS

PAGE 1	COVER
PAGE 2	TABLE OF CONTENTS
PAGE 3	PROJECT DESCRIPTION
PAGE 3	DRAINAGE AREAS
PAGE 4	METHODOLOGY
PAGE 4	PROPOSED DRAINAGE FACILITIES
PAGE 4	OFFSITE-IMPACTS
PAGE 5	CONCLUSIONS
APPENDIX	VICINITY MAP
	MAP - OFFSITE BASIN RUN-OFF
	MAP - PROPOSED DRIVEWAY CONDITIONS
	COMPARISON TABLE – EXISTING AND PROPOSED CONDITIONS
	SITE SPECIFIC IDF CURVES
	100 YEAR 6 & 24 HOUR ISOPLUVIALS
	100-YEAR STORM HYDROGRAPHS
	100-YEAR CHANNEL DEPTH CALCULATIONS
	TABLE 3-1 - RUNOFF COEFFICIENTS FOR URBAN AREAS
	TABLE 3-2 - MAXIMUM OVERLAND FLOW LENGTH (Lm) & INITIAL TIME OF CONCENTRATION (Ti)
	FIGURE 3-3 OVERLAND TIME OF FLOW NOMOGRAPH
	FIGURE 3-4 NOMOGRAPH FOR TIME OF CONCENTRATION (Tc)
	COUNTY OF SAN DIEGO SOIL HYDROLOGIC GROUPS

PROJECT DESCRIPTION

The Spitsbergen Residence Driveway project is located on a 177 acre parcel (A.P.N. 327-031-02) in the southern portion of Ramona, south of Dye Road. The proposed driveway would connect the existing single-family residence to Southern Oak Road which is a public street and part of the Holly Oaks Ranch (County of San Diego Tract No. 4862) subdivision.

The terrain is generally steep, with stands of Southern Coast Live Oak, areas of coastal sage scrub and dotted with exposed rock outcroppings. In general, drainage patterns flow from west to east, traverse from offsite crossing the western side of the Spitsbergen property line toward Daney Canyon located immediately to the east of the property.

This project proposes paving the existing graded driveway with a 16' wide paved asphalt driveway with a minimum pavement section per Ramona Fire Department standards. The proposed vertical and horizontal alignment of the new driveway shall follow as close as possible to the existing alignment. Storm run-off from the paved driveway shall be directed towards asphalt concrete spillways and energy dissipators via asphalt concrete berms. Concrete aprons shall be used wherever the existing dirt driveway crosses existing streambeds to allow for natural stream flows. A two foot wide vegetated grass-lined swale along the road shoulder shall treat any direct run-off from the new pavement. Type 'B' drainage ditches (RSD D-75) have been proposed at the top of all cut slopes and at the toe of all fill slopes where necessary.

DRAINAGE AREAS

The existing driveway currently crosses five drainage channels (E1 thru E5) and each channel provides drainage for an area extending from well offsite (see the map "Off-site Basin Run-off" in the Appendix of this report). These areas are 11.12, 1.31, 658.30, 3.00, and 26.89 acres in size.

Drainage Basin E1 includes a large portion of the developed Holly Oaks Ranch subdivision. The graded pads and streets of the subdivision have altered the drainage characteristics of the contributing upstream drainage basin for B1. However, the run-off values are tabulated on the associated grading plans. Therefore, this tabulated developed runoff is included in the overall volume of runoff attributed to Basin B1.

A majority of the Spitsbergen property east (downstream) of the driveway is not included in the analysis of any of the drainage basins within this report. These areas follow the natural terrain flowing east towards Daney Canyon.

METHODOLOGY

This drainage study is an analysis for the proposed driveway. The County of San Diego June 2003 Hydrology Manual was used for this report.

Because most of the drainage areas are relatively small, the County of San Diego Rational Method was utilized for computing the anticipated run-off volumes. For drainage Basin E2, which is slightly larger than one square mile (658.30 sq-mi), the U.S. Soil Conservation Service unit hydrograph method, or modified rational methods could be utilized. However, for this study, the rational method was used for the analysis of all basins, and this method should provide a conservative result for drainage Basin E2.

For existing conditions, the Time of Concentration values (T_c), were calculated using the formula on Figure 3-3 for Initial Time of Concentration (T_i), and Figure 3-4 for the Travel Time of Concentration (T_t), portion of the overall T_c . Since the new driveway will be aligned along the existing driveway at the same line and grade for the developed conditions, the Travel Time of Concentration (T_c) used in the computation of run-off for the existing condition shall still be used. The Runoff Coefficients (C) were obtained from Table 3-1. For the existing condition, a runoff coefficient of 0.41 was used due to the exclusive natural terrain of the site. For the developed condition, a run-off coefficient of 0.82 is used to reflect the difference between the graded and paved conditions. A site specific IDF curve was generated using Hydrflow Hydragraphs for Windows software and the appropriate isopluvial charts for the 2, 5, 10, 25, 50 and 100-year storm events. The area (A) of each basin was obtained from AutoCAD Softdesk software. The runoff rate is computed using the rational formula, $Q(100) = CIA$.

PROPOSED DRAINAGE FACILITIES

This project proposes a 16' wide asphalt concrete driveway designed to follow the alignment of the existing graded dirt driveway. An A.C. berm shall be used to control impervious runoff by directing flows to A.C. spillways and energy dissipators via vegetated swales along the road shoulder. Energy dissipators shall be sized to regional standards to reduce the impacts of downstream erosion. Concrete low-water crossings shall be used to maintain the flow of existing streambed crossings. Drainage ditches shall be used to protect proposed slopes.

OFF-SITE IMPACTS

As previously indicated, the entire project site drains easterly toward Daney Canyon. Of the approximately 703 (703.02) acres comprising the drainage areas included within this study, approximately 679 acres are offsite to the west. Consequently, the combined onsite drainage areas, including the areas of proposed driveway, equal 22 acres which is approximately 3% of the total 703 acres draining through the Spitsbergen property towards Daney Canyon.

The Comparison Table (included in the Appendix) shows an increase between the existing graded driveway areas and the proposed paved driveway areas is approximately 6.52 cfs (13.04 cfs-6.52 cfs). This would increase the overall runoff towards Daney Canyon by less than 1% (0.70%):

E1 = 24.41 cfs

E2 = 3.56 cfs

E3 = 814.98 cfs

E4 = 7.66 cfs

E5 = 59.42 cfs

A0-A10 = 6.52 cfs

Total = 916.55 cfs

$$6.52/916.55 = 0.007$$

Daney Canyon is located immediately offsite to the east of the project boundary and is a major natural watershed which drains significantly more area than that included in the drainage areas within this report. For the purposes of this project, the 0.7% increase in run-off generated by the new pavement does not appear to create a significant overall impact.

The proposed driveway has been designed to allow natural flow of the existing streambeds using low water concrete crossings. Rip-rap energy dissipators will be constructed as part of each A.C. spillway structure to help reduce run-off velocity. More importantly, upon exiting the rip-rap, the run-off will flow downstream, across the eastern portion of the property and traverse at least 1,000 feet of open space with a much higher roughness coefficient before exiting the property. Consequently, there should be no significant increase in off-site drainage velocity due to the proposed driveway.

CONCLUSIONS

Based upon the analysis, the proposed driveway will be capable of passing the estimated 100-year flood run-off rates. The proposed grading and drainage facilities will be in compliance with the requirements of the County of San Diego Public Works Department and the San Diego Regional Standard Drawings. The increased drainage run-off generated by the proposed driveway pavement should not create a significant overall impact since the paved surface area constitutes such a minor portion of the total Daney Canyon drainage basin.

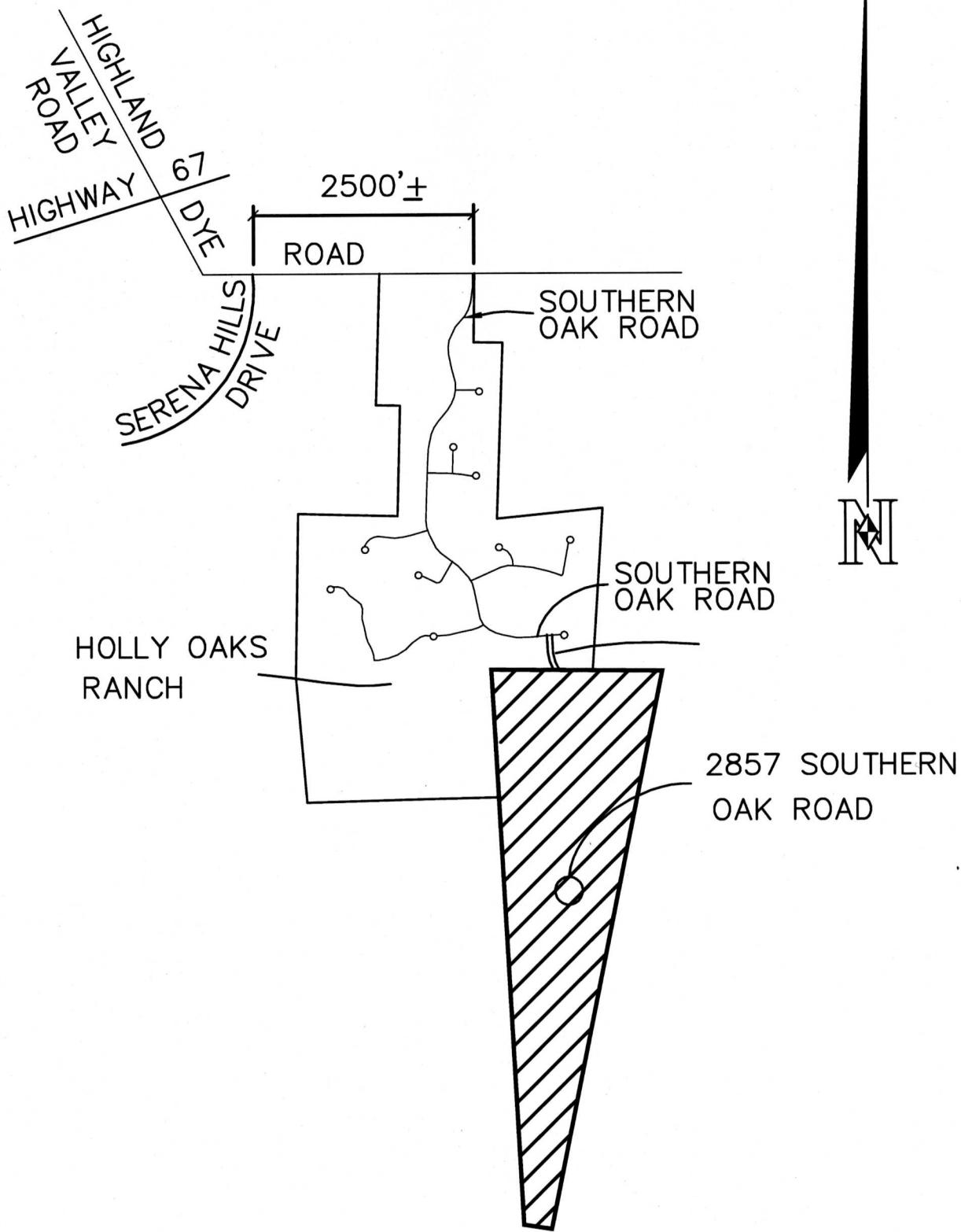
Prepare under the supervision of

Robert C. Haynes Date 9-3-08

Robert C. Haynes, PE
C25593, exp 12/31/09

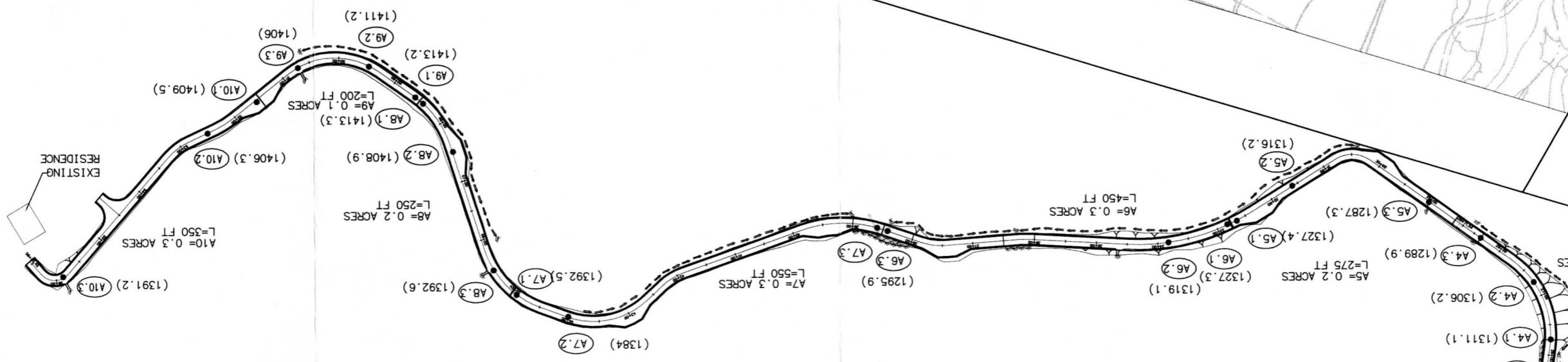


APPENDIX



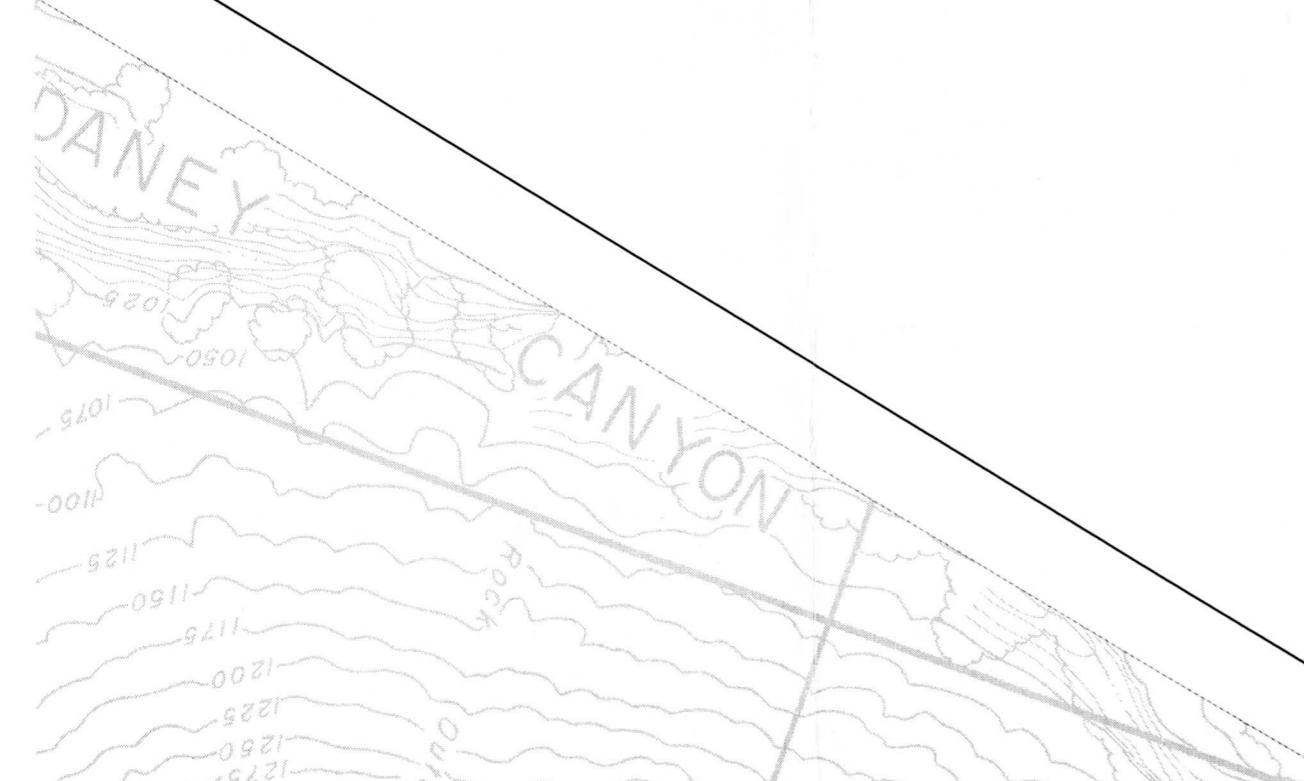
VICINITY MAP
NO SCALE

GRADING PLAN L-14522
EXHIBIT B
PROPOSED PAVEMENT AREAS



SCALE: 1"=200'

SOUTHERN OAK ROAD



Hydrology Storm Run-off Calculations Comparison Table

C Existing	C Proposed
0.41	0.82

Assumptions: (1) Lm=100' initial length @10%, (2) Existing C=0.41, (3) Proposed C=0.82, (4) Slopes are averaged over basin

Basin/ Node	EXISTING CONDITIONS							PROPOSED CONDITIONS						
	Area acres	Elevation feet	L feet	L miles	H feet	S %	Ti minutes	Tt minutes	Tc minutes	I(100) in/hr	Q(100) existing	Q(100) proposed	V ft/sec	Q(100) increase
Existing														
E1	11.12	1415												
		1272	1,400	0.2652	143	0.10	6.9	4.97	11.87	5.35	24.41	24.41	0.00	
E2	1.31	1385												
		1304	443	0.0839	81	0.18	6.9	1.64	8.54	6.62	3.56	3.56	0.00	
E3	658.3	1940												
		1290	8,390	1.589	650	0.08	6.9	21.96	28.86	3.02	814.98	814.98	0.00	
E4	3	1437												
		1306	750	0.142	131	0.17	6.9	2.50	9.40	6.22	7.66	7.66	0.00	
E5	26.89	1662												
		1293	1,880	0.3561	369	0.20	6.9	4.85	11.75	5.39	59.42	59.42	0.00	
		700.62									910.03			
A0.1		1321.7												
A0.2		1316.2	100											
A0.3	0.1	1313.36	55	0.01	2.84	5.16	7.2	0.53	7.72	7.07	0.29	0.58	1.49	0.29
A1.1		1312.38												
A1.2		1310	100											
A1.3	0.4	1279	680	0.13	31	4.56	7.5	3.89	11.38	5.50	0.90	1.80	2.28	0.90
A2.1		1323.67												
A2.2		1319.25	100											
A2.3	0.3	1279	500	0.09	40.25	8.05	6.2	2.47	8.66	6.56	0.81	1.61	2.64	0.81
A3.1		1323.67												
A3.2		1323.4	100											
A3.3	0.1	1315.2	100	0.02	8.2	8.20	6.2	0.71	6.87	7.62	0.31	0.62	1.77	0.31
A4.1		1311.1												
A4.2		1306.2	100											
A4.3	0.1	1289.9	100	0.02	16.3	16.30	4.9	0.54	5.44	8.86	0.36	0.73	2.30	0.36
A5.1		1327.4												
A5.2		1316.2	100											
A5.3	0.2	1287.3	275	0.05	28.9	10.51	5.7	1.40	7.07	7.48	0.61	1.23	2.54	0.61
A6.1		1327.3												
A6.2		1319.1	100											
A6.3	0.3	1295.9	450	0.09	23.2	5.16	7.2	2.70	9.89	6.02	0.74	1.48	2.25	0.74
A7.1		1392.5												
A7.2		1384	100											
A7.3	0.3	1295.9	550	0.10	88.1	16.02	4.9	2.04	6.96	7.55	0.93	1.86	3.42	0.93
A8.1		1413.3												
A8.2		1408.9	100											
A8.3	0.2	1392.6	200	0.04	16.3	8.15	6.2	1.21	7.38	7.27	0.60	1.19	2.33	0.60
A9.1		1413.2												
A9.2		1411.2	100											
A9.3	0.1	1406	200	0.04	5.2	2.60	9.0	1.88	10.91	5.65	0.23	0.46	1.12	0.23
A10.1		1409.5												
A10.2		1406.3	100											
A10.3	0.3	1391.2	350	0.07	15.1	4.31	7.6	2.38	10.01	5.98	0.74	1.47	2.13	0.74

2.4

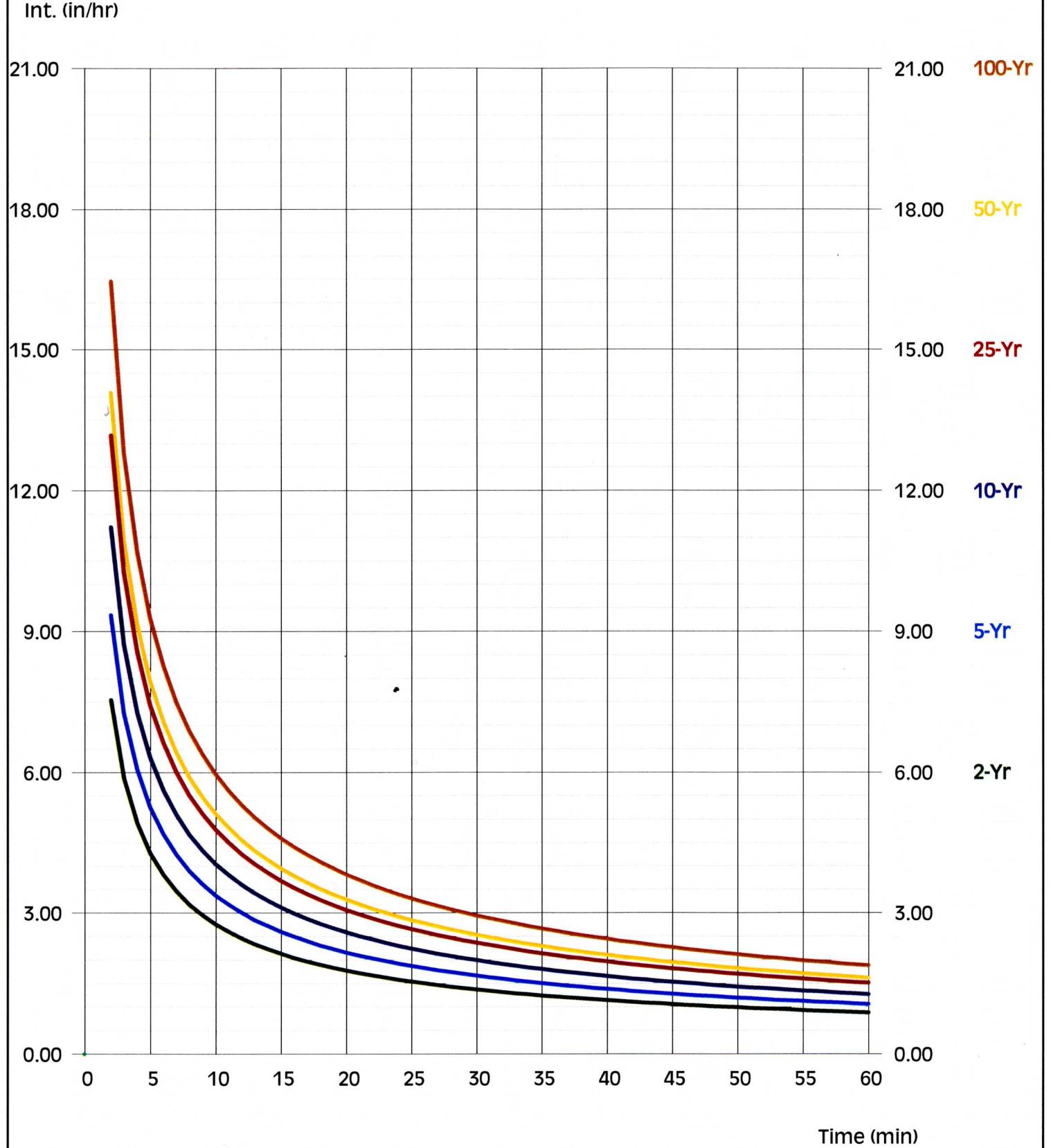
6.52

13.04

6.52

Hydrograph IDF Curves

IDF file: Spitsbergen.IDF



ISOPLUVIAL VALUES

Storm Event	P6 6-hour	P24 hour	24 hour	P6/P24	P6 Used	Duration (min)				
						5	10	15	30	60
2-year	1.65	2.55	0.65	1.66	4.37	2.79	2.15	1.37	0.88	
5-year	2.00	3.55	0.56	2.00	5.27	3.37	2.59	1.66	1.06	
10-year	2.40	4.10	0.59	2.40	6.32	4.04	3.11	1.99	1.27	
25-year	2.85	5.05	0.56	2.85	7.51	4.80	3.70	2.36	1.51	
50-year	3.05	5.55	0.55	3.05	8.04	5.14	3.96	2.53	1.62	
100-year	3.55	6.05	0.59	3.55	9.35	5.98	4.60	2.94	1.88	

** Note: 10 minute duration not used in Hydrographs for Windows program to set up site-specific custom IDF

County of San Diego Hydrology Manual



Rainfall Isopluvials

100 Year Rainfall Event - 24 Hours



We Have San Diego Located

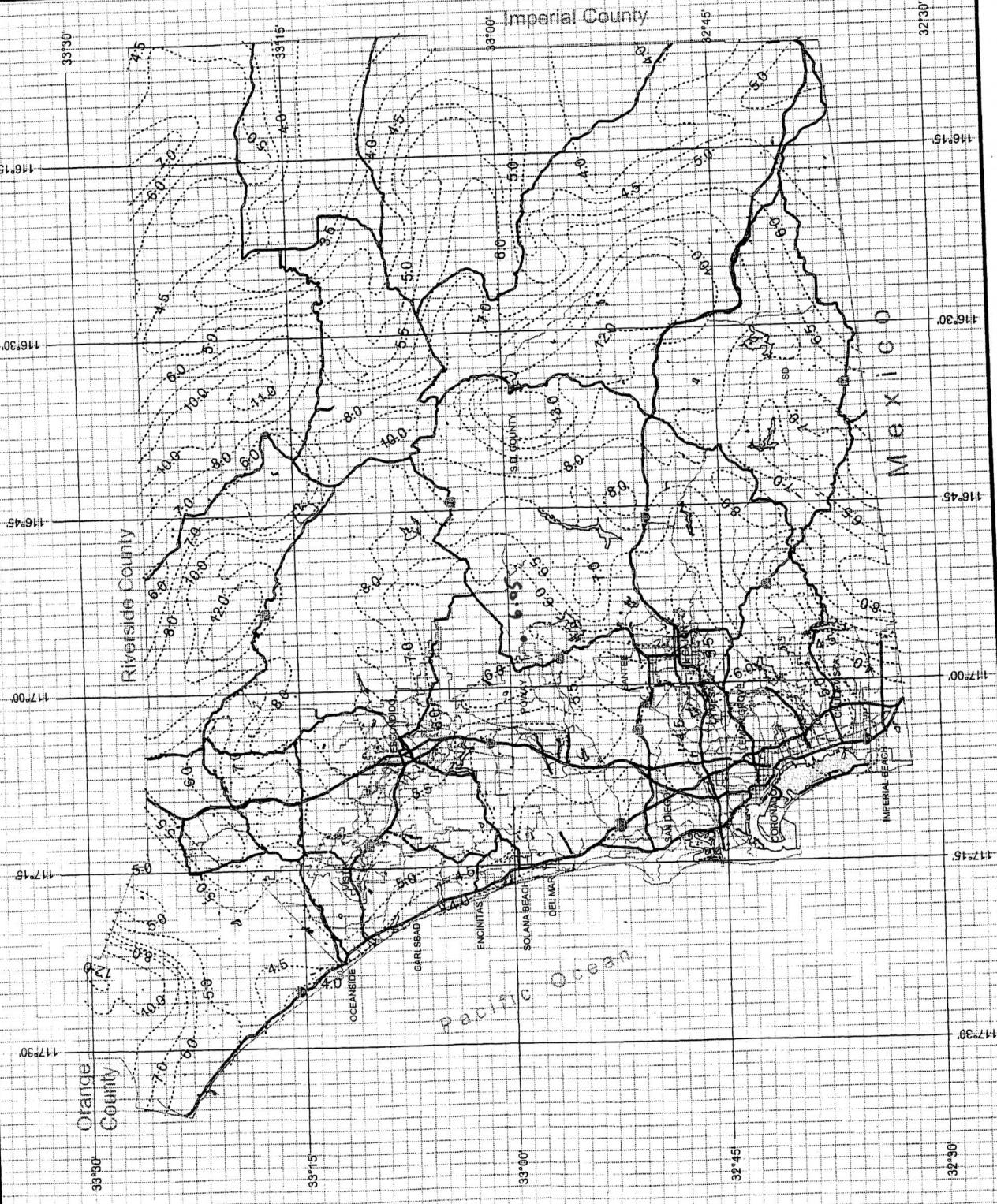
This map is provided without warranty of any kind, either express or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.

Copyright Services, A Regional Company

The products and services offered herein are provided by DPPW, Regional Water Planning and Conservation Services, Inc., a wholly-owned subsidiary of San Diego Regional Water Authority. No portion of this map may be reproduced without permission of San Diego Regional Water Authority.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.

Permission granted by Thomas Brothers Maps.



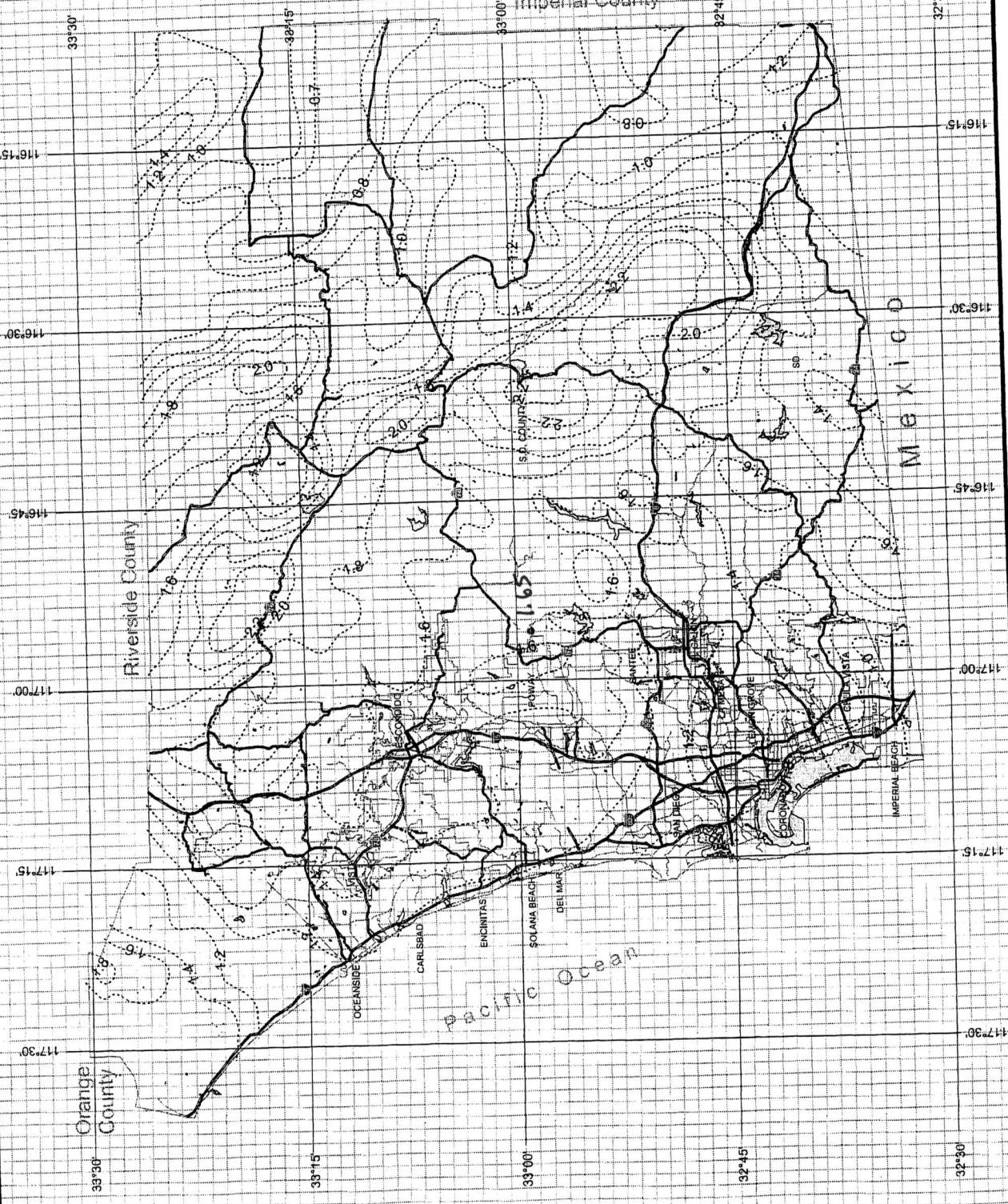
County of San Diego Hydrology Manual



Rainfall Isopluvials

2 Year Rainfall Event - 6 Hours

Isopluvial (inches)



SanGIS
W.C. Harris, San Diego, California

This map is provided without warranty of accuracy, either express or implied, by the San Diego Regional Information System.

THE MAP IS PROVIDED "AS IS" AND THE SAN DIEGO REGIONAL INFORMATION SYSTEM DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT.

Copyright SanGIS. All Rights Reserved.

This product may contain information from the SANDAG Regional Information System which cannot be reproduced without the written permission of SANDAG.

This product may contain information which has been reproduced with permission of various other entities.

This product may contain information which has been reproduced with permission of various other entities.

Miles

3

0

3

N

S

E

W

3 Miles

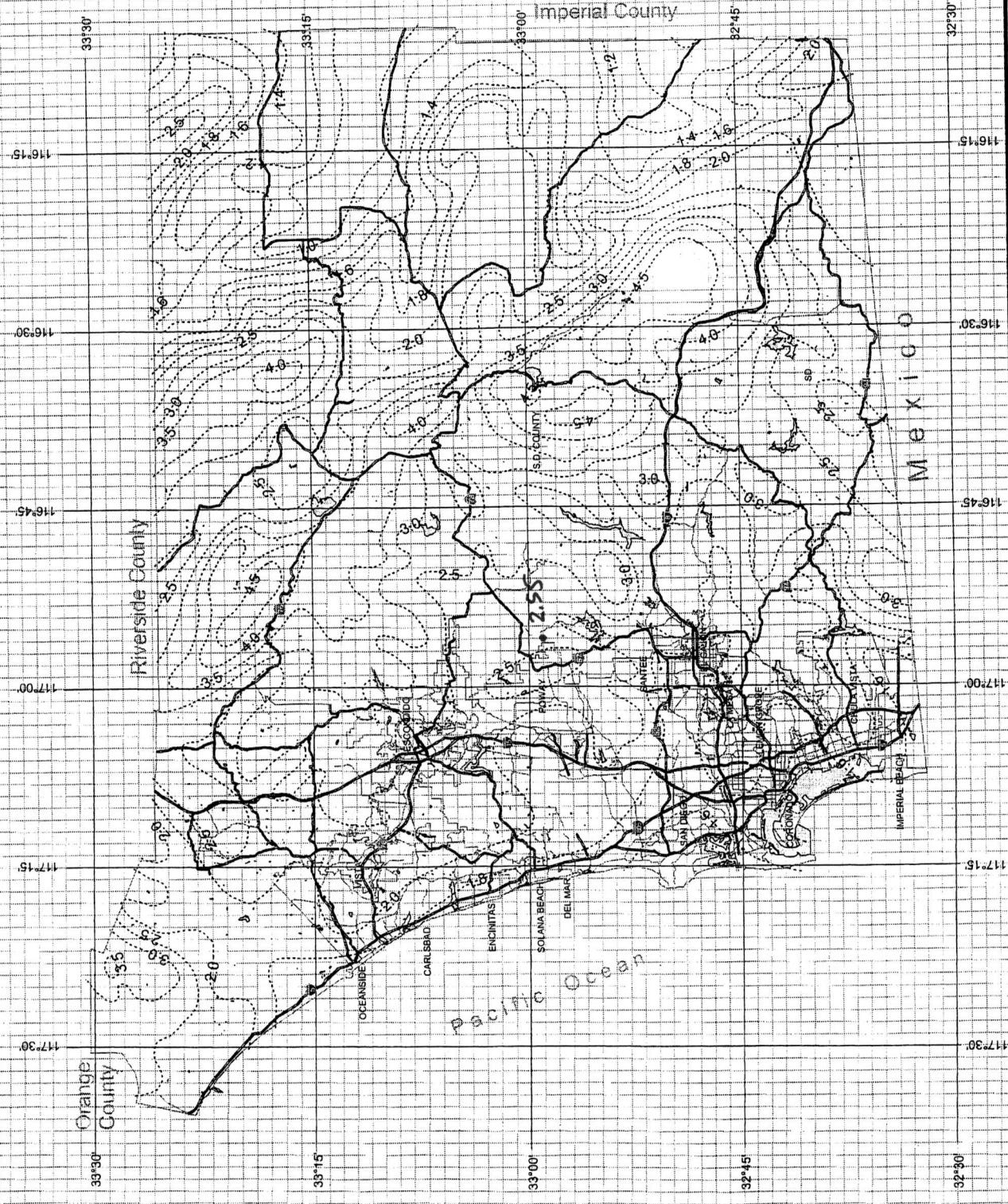
County of San Diego Hydrology Manual



Rainfall Isopluvials

2 Year Rainfall Event - 24 Hours

Isopluvial (Inches)
.....



W.C. Hayes San Diego County

DWP GIS
2000-2001 Rainfall Data

This map is provided without warranty of any kind and either express or implied. It is intended to be used for a particular purpose only. All rights reserved. Copyright 2001. All rights reserved.

This product may contain information from the San Diego Regional Water Quality Control Board. No part of this document may be reproduced without written consent of the San Diego Regional Water Quality Control Board. This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.



3 Miles

32°30'

32°30'

32°30'

32°30'

32°30'

32°30'

32°30'

32°30'

0

3

Miles

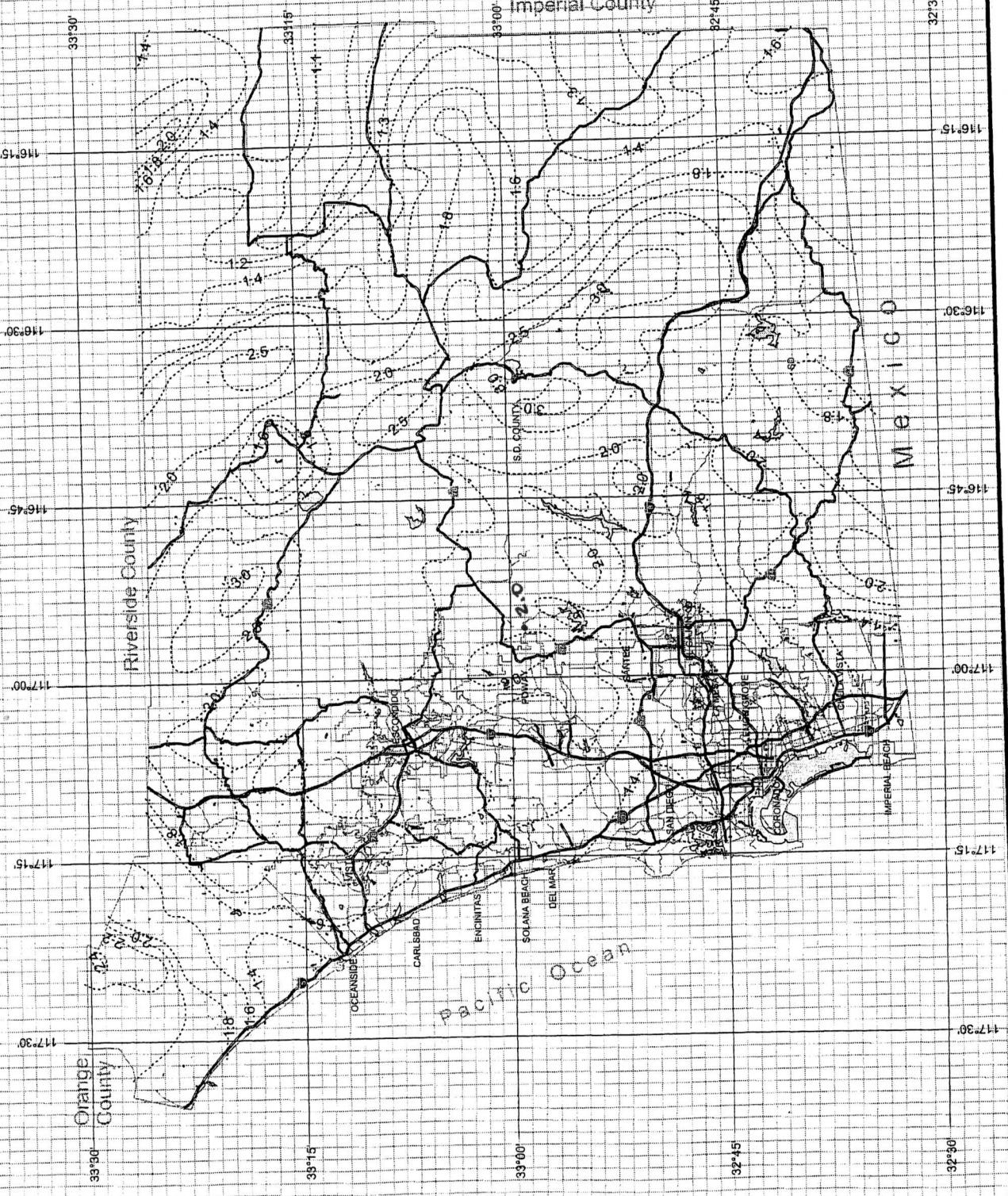
County of San Diego Hydrology Manual



Rainfall Isopluvials

5 Year Rainfall Event - 6 Hours

..... Isopluvial (inches)



SanGIS
City of San Diego, CA

DPW GIS
Department of Public Works
City of San Diego, CA

DISCLAIMER OF LIABILITY:
THIS MAP IS PROVIDED UNDERTAKEN WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. COPYING, SALES, AND OTHER FEATURES ARE PROHIBITED.
This product may contain information from the SanGis Database and/or other sources. All rights reserved. The material contained herein is the property of the City of San Diego, CA. It is intended for internal use within government of San Diego, CA.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.



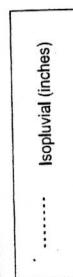
3 Miles

County of San Diego Hydrology Manual



Rainfall Isopluvials

5 Year Rainfall Event - 24 Hours



WE HAVE SAN DIEGO Connected!

San Diego Regional Information System

Department of Planning and Environment

City of San Diego

County of San Diego

City of Chula Vista

City of Imperial Beach

City of National City

City of Oceanside

City of San Marcos

City of San Ysidro

City of Spring Valley

City of Vista

City of El Cajon

City of La Mesa

City of Rancho Bernardo

City of Rancho Cucamonga

City of Rancho Santa Margarita

City of San Juan Capistrano

City of San Marcos

City of San Pedro

City of San Ysidro

City of Spring Valley

City of Vista

City of El Cajon

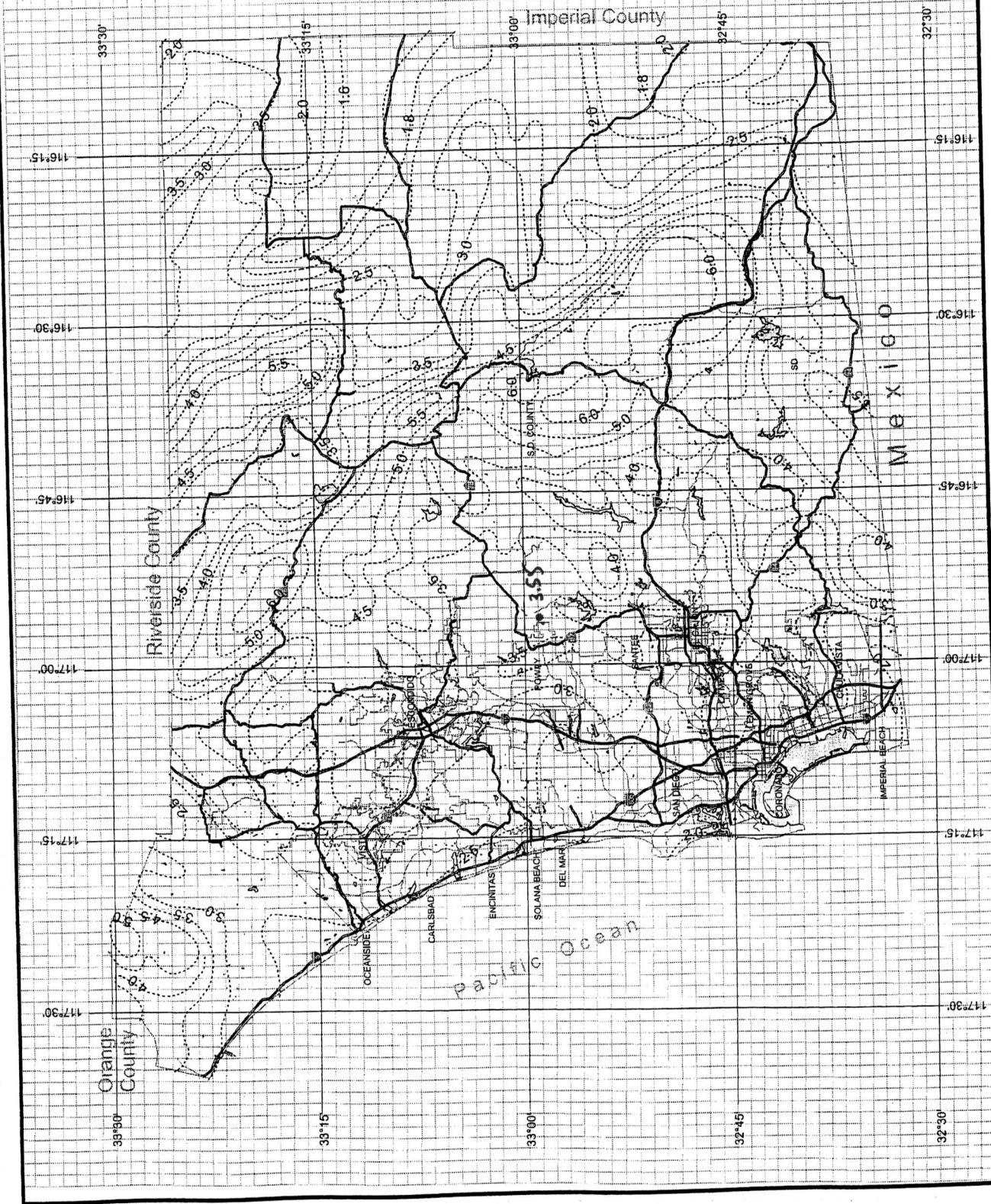
City of La Mesa

City of Rancho Bernardo

City of Rancho Cucamonga

City of San Juan Capistrano

City of San Marcos

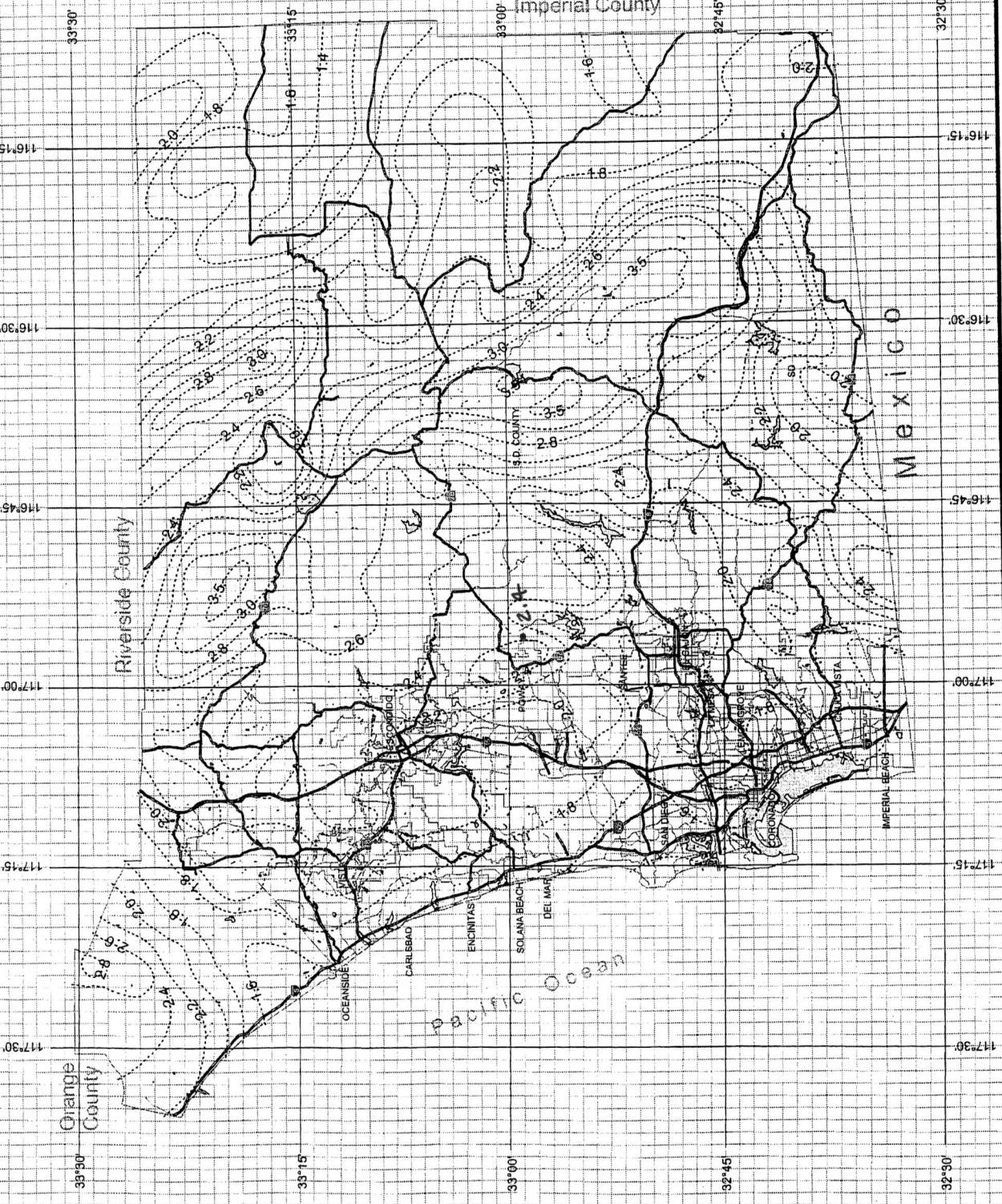


County of San Diego Hydrology Manual



Rainfall Isopluvials

10 Year Rainfall Event - 6 Hours



We Have San Diego Covered

DPW
GIS

Geospatial & Public Works

Information & Analysis Program

This map is provided "AS IS" without warranty of any kind, either express or implied, including, but not limited to, the implied warranties of MERCHANTABILITY and FITNESS FOR A PARTICULAR PURPOSE.

Copyright 2005. All rights reserved.

This product may contain information from the San Diego Regional

Integrated System and/or be copyrighted which the

owner retains all rights thereto.

This product may contain information that has been reproduced with

permisssion granted by Thomas Bros. Inc. to Mapco.



3 Miles
3 0 3

32°30'

N

S

E

W

County of San Diego Hydrology Manual



Rainfall Isophylials

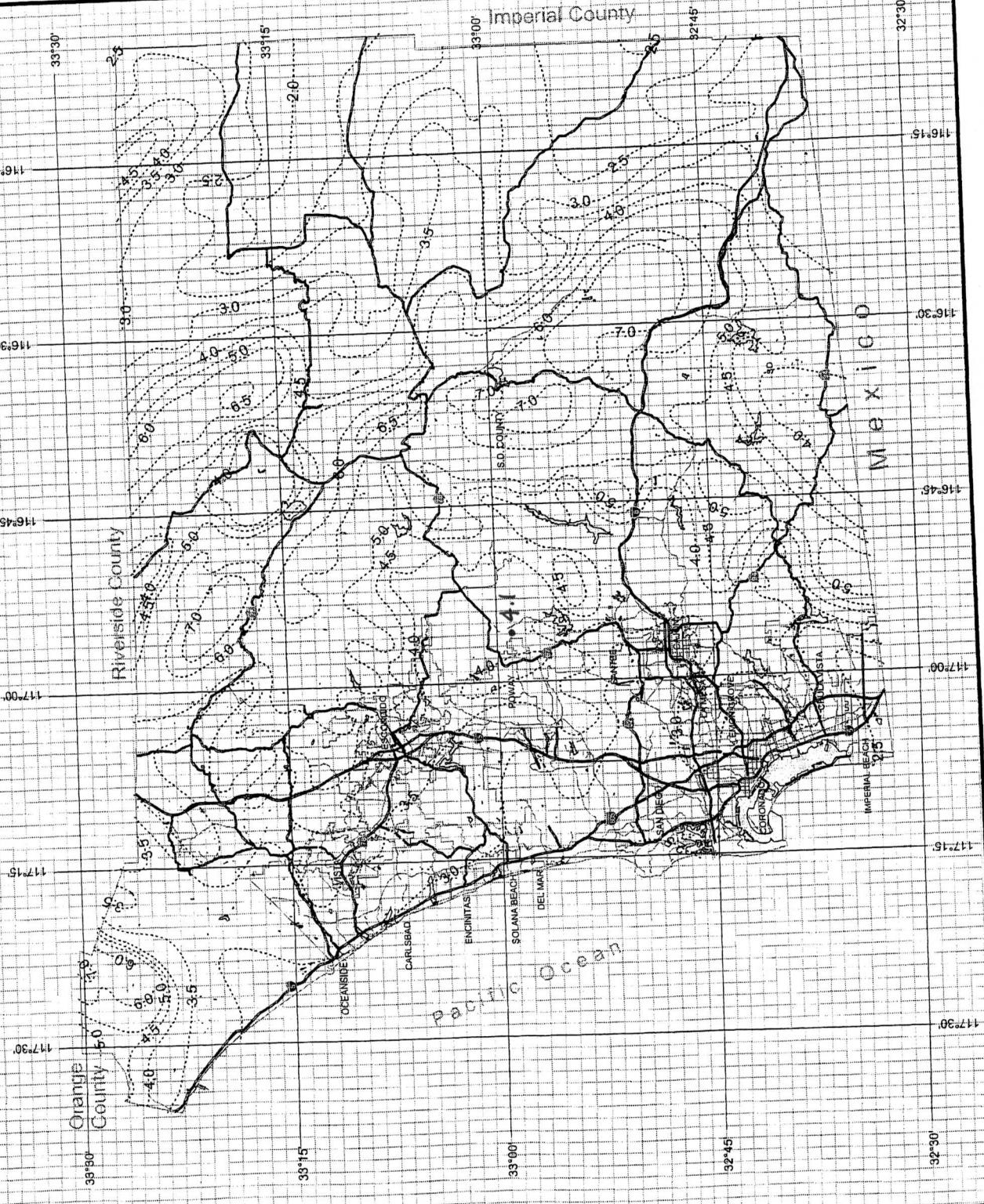
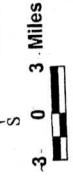
10 Year Rainfall Event - 24 Hours

..... Isopluvial (inches)



DPW GIS
Department of Public Works
San Diego, California

We Have San Diego Covered!
THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.
Copyright SanGIS. All rights Reserved.
This product contains information from the SANDAG Regional Information System and is provided under license from SANDAG.
Information contained in this document was developed with the participation of the San Diego Association of Governments.



County of San Diego Hydrology Manual



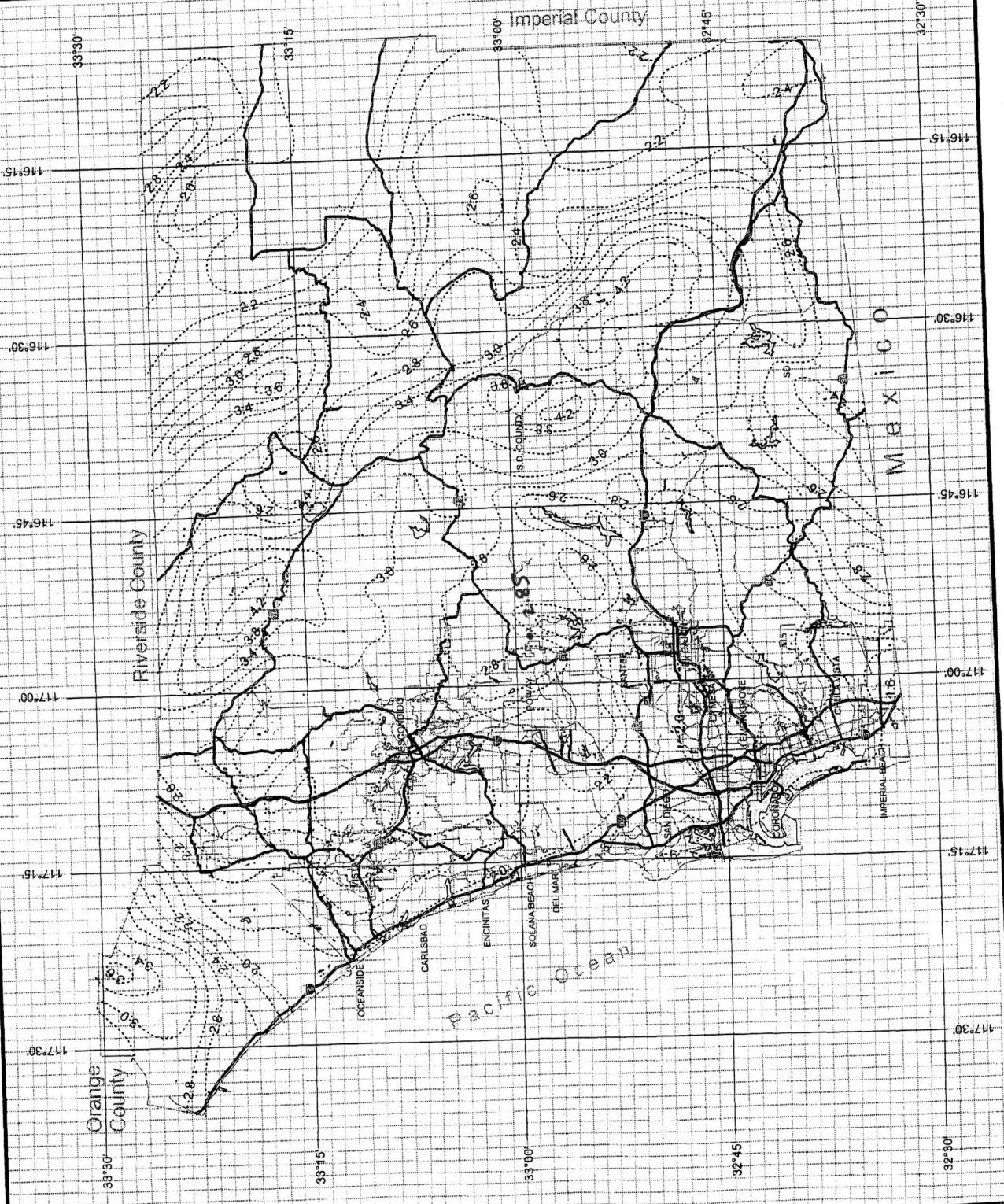
Rainfall Isophluvials

25 Year Rainfall Event - 6 Hours



Department of Public Works
Planning and Surveying Division
Imperial Valley Regional Water Conservation System
The map is provided without warranty of any kind, either express or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Copying or distribution of all rights reserved.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps Inc.



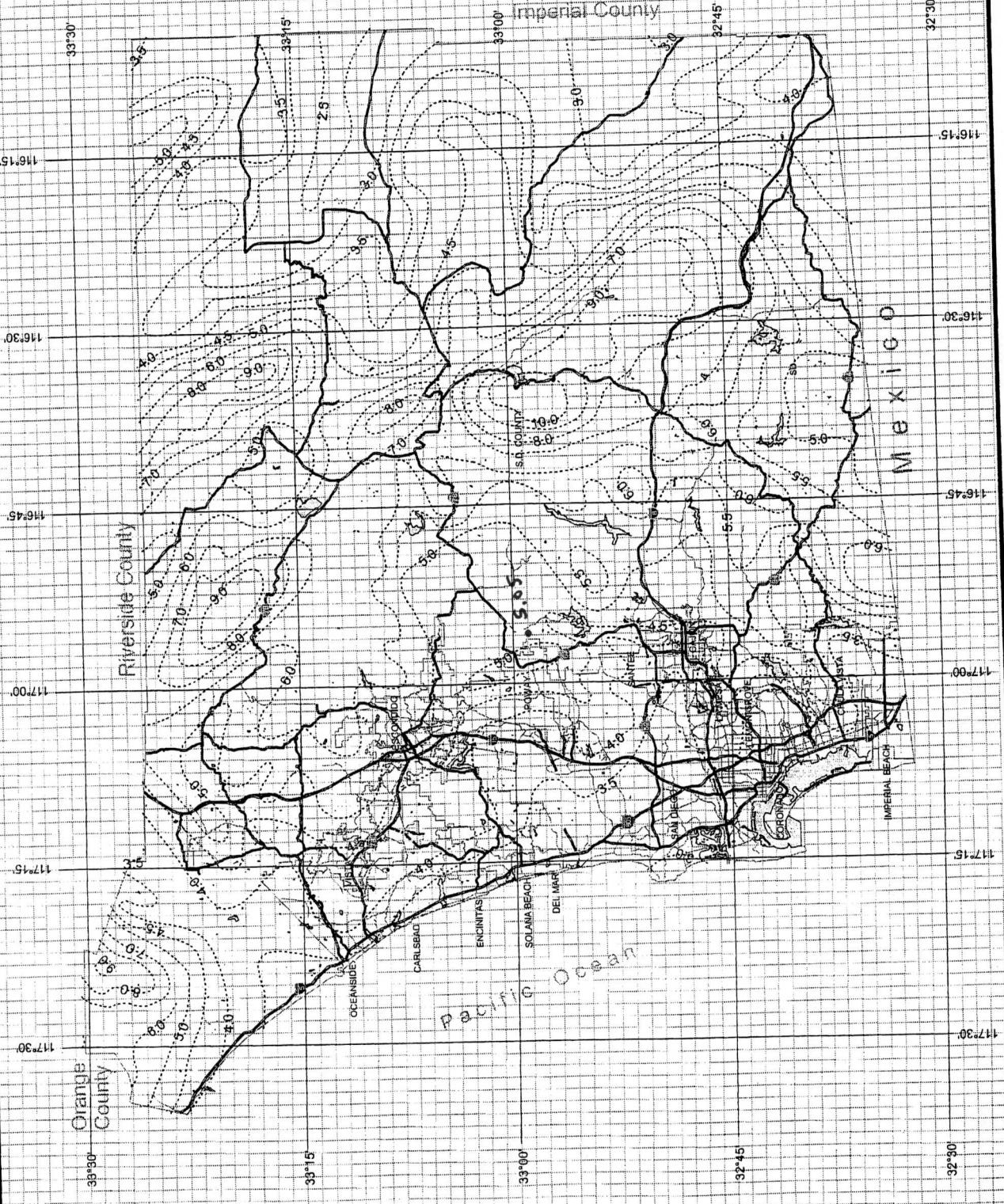
County of San Diego Hydrology Manual



Rainfall Isopluvials

25 Year Rainfall Event - 24 Hours

..... Isopluvial (inches)



We Have San Diego's Back!

SanGIS
Department of Planning & Development
City of San Diego, California

THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. COPIES ARE FOR INTERNAL USE ONLY. ALL RIGHTS RESERVED.

This product may contain information from the SANDAG Regional Household Survey which cannot be reproduced without the written permission of SANDAG.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.



3 Miles

County of San Diego Hydrology Manual



Rainfall Isophivials

50 Year Rainfall Event - 24 Hours

Isophivial (inches)



We Have San Diego Covered

San Diego Regional Information System

San Diego County GIS

City of San Diego GIS

County of San Diego GIS

City of Chula Vista GIS

City of El Cajon GIS

City of Imperial Beach GIS

City of La Jolla GIS

City of Lemon Grove GIS

City of National City GIS

City of Oceanside GIS

City of Pacific Beach GIS

City of Rancho Bernardo GIS

City of San Marcos GIS

City of San Ysidro GIS

City of Spring Valley GIS

City of Vista GIS

City of West Covina GIS

DPIW GIS

New Mexico State GIS

City of Alamogordo GIS

City of Carlsbad GIS

City of Roswell GIS

City of Truth or Consequences GIS

City of Tularosa GIS

City of Alamogordo GIS

City of Carlsbad GIS

City of Roswell GIS

City of Truth or Consequences GIS

City of Tularosa GIS

City of Alamogordo GIS

City of Carlsbad GIS

City of Roswell GIS

City of Truth or Consequences GIS

City of Tularosa GIS

City of Alamogordo GIS

N

S

E

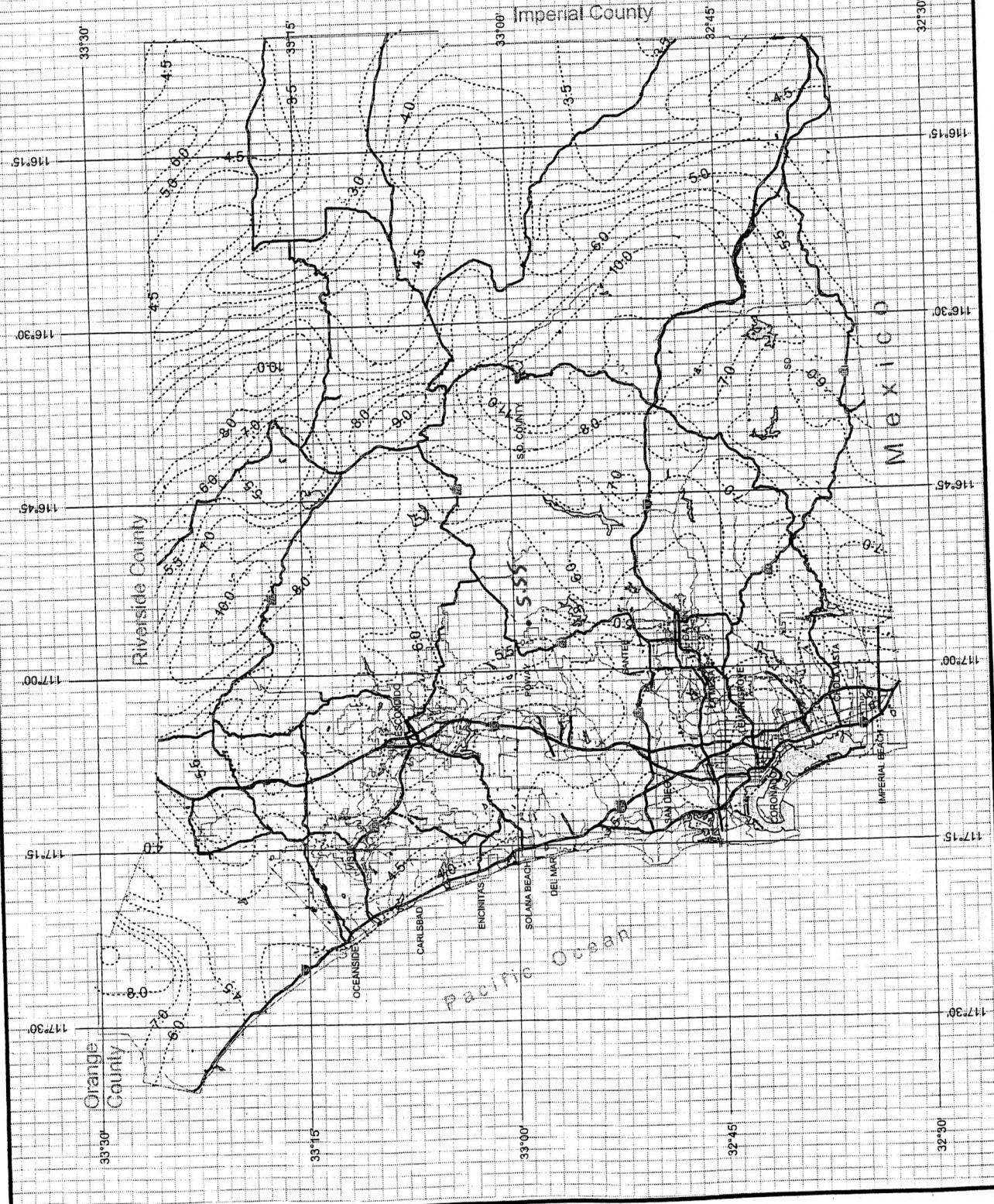
W

3

0

3

Miles



County of San Diego Hydrology Manual



Rainfall Isopluvials

50 Year Rainfall Event - 6 Hours

Isopluvial (inches)

.....



We Have

San Diego Connected



Department of Public Works
Geospatial Information Division

This map is provided without warranty of any kind, either express or implied, including but not limited to the implied warranty of merchantability and fitness for a particular purpose. Copyright 2001. All rights reserved.

This product may contain information from the Sanjour Region which is the property of SANDAG.

While permission is granted by SANDAG to reproduce and/or

display this map for internal purposes, no permission is granted to reproduce and/or

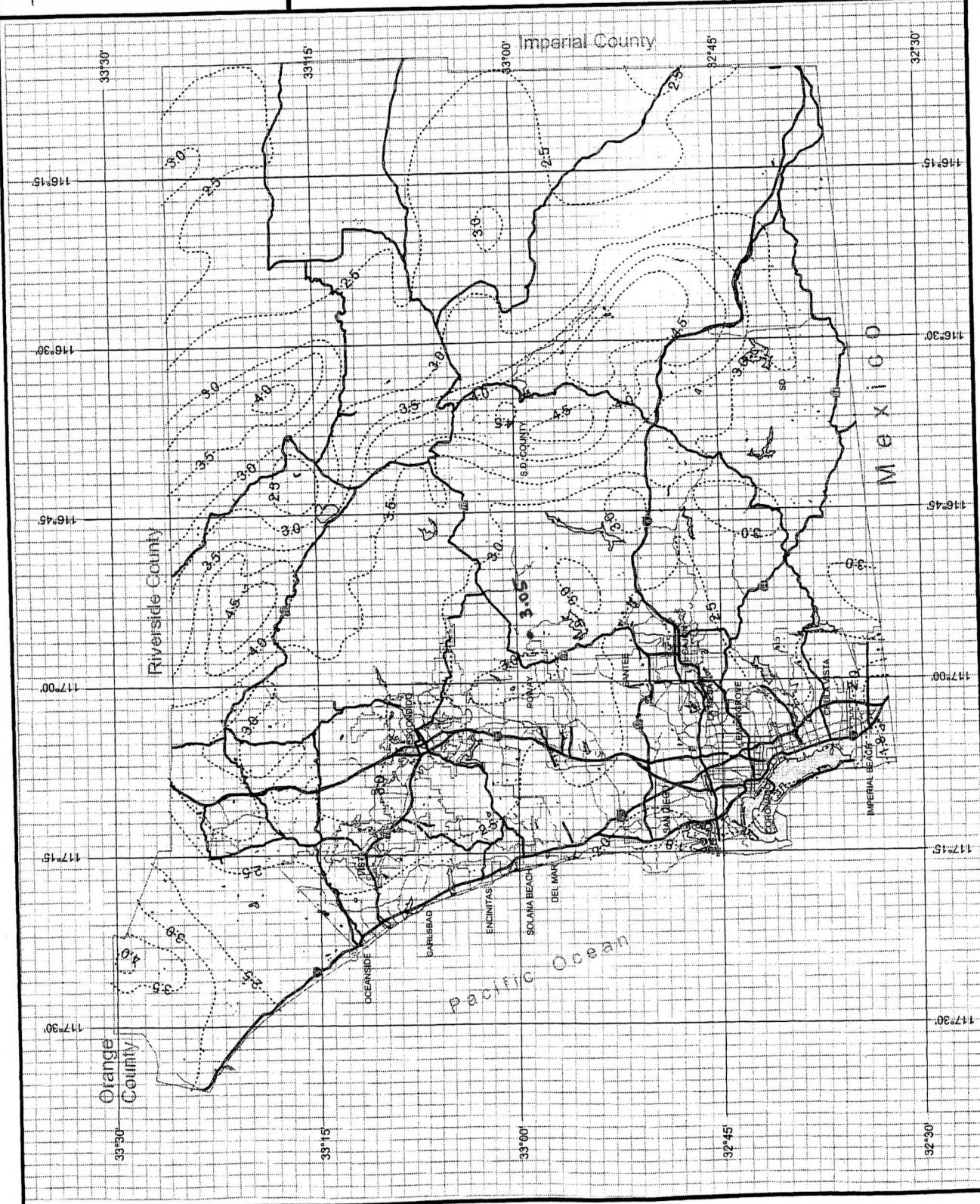
distribute this map outside the Sanjour Region.

This product may contain information which has been reproduced with

permission granted by Thomas Brothers Maps.



3 Miles

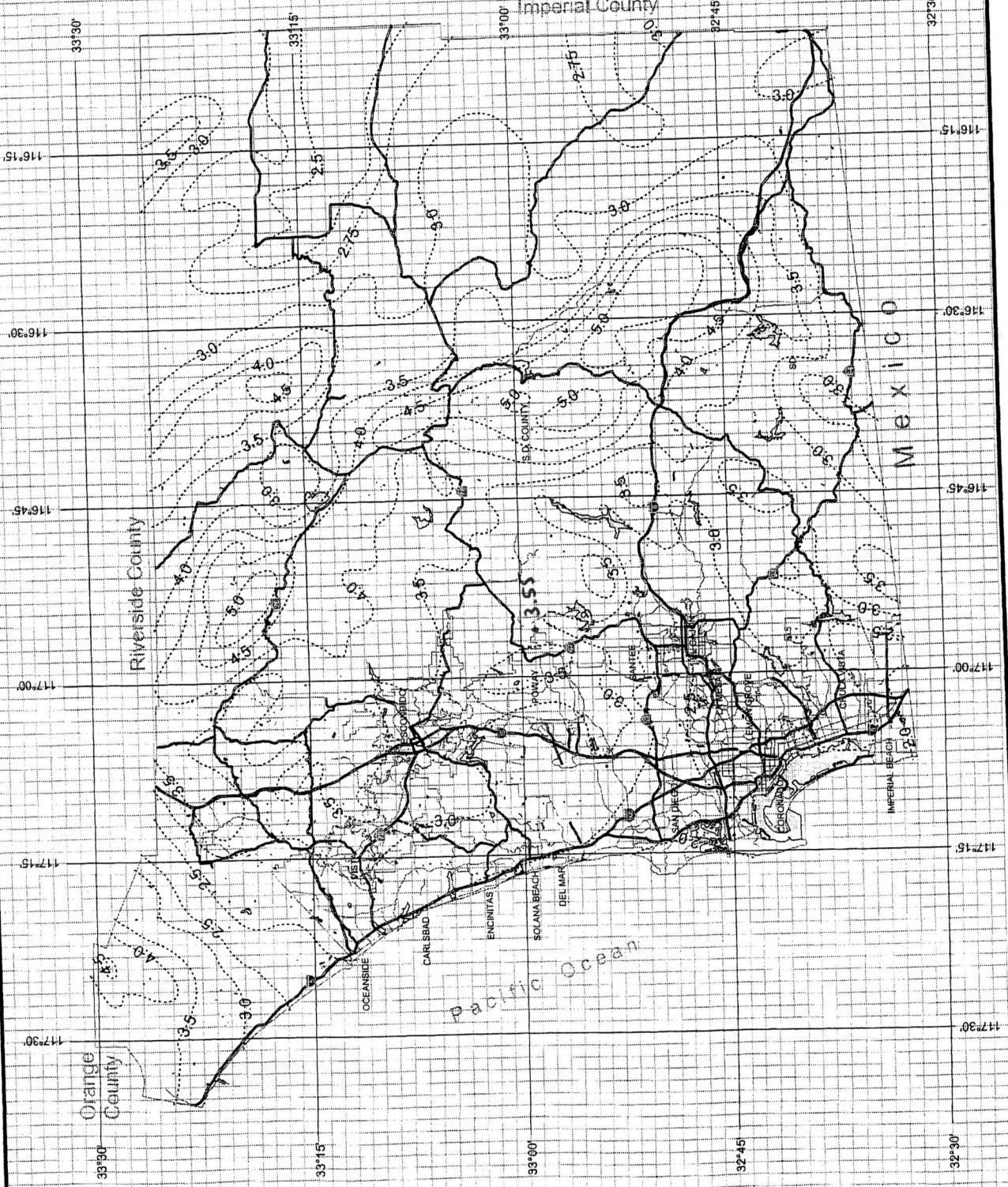
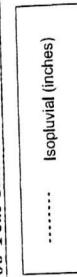


County of San Diego Hydrology Manual



Rainfall Isophivials

100 Year Rainfall Event - 6 Hours



SanGIS

We Have San Diego Covered.
Department of Public Works
Government of the People of San Diego

DPW GIS
Department of Public Works
Government of the People of San Diego

This product is distributed without warranty of any kind, either express or implied, including but not limited to the implied warranties of MERCHANTABILITY and FITNESS FOR A PARTICULAR PURPOSE. Copyright San Diego Regional Planning Commission. All rights reserved.

This product may contain information owned by the San Diego Regional Planning Commission which is protected by copyright laws.

This product may contain information which has been reproduced with permission granted by Thomas Brothers Maps.



3

0

3

Miles

Table of Contents

Spitsbergen.gpw

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

Hydrograph Return Period Recap 1

100 - Year

Summary Report	2
Hydrograph Reports	3
Hydrograph No. 1, Rational, E1	3
Hydrograph No. 2, Rational, E2	4
Hydrograph No. 3, Rational, E3	5
Hydrograph No. 4, Rational, E4	6
Hydrograph No. 5, Rational, E5	7
Hydrograph No. 6, Rational, A0	8
Hydrograph No. 7, Rational, A1	9
Hydrograph No. 8, Rational, A2	10
Hydrograph No. 9, Rational, A3	11
Hydrograph No. 10, Rational, A4	12
Hydrograph No. 11, Rational, A5	13
Hydrograph No. 12, Rational, A6	14
Hydrograph No. 13, Rational, A7	15
Hydrograph No. 14, Rational, A8	16
Hydrograph No. 15, Rational, A9	17
Hydrograph No. 16, Rational, A10	18

Hydrograph Return Period Recap

Hydrograph type (origin)	Inflow Hyd(s)	Peak Outflow (cfs)								Hydrograph description
		1-Yr	2-Yr	3-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr	
Rational	----	----	11.19	----	----	16.40	----	----	24.16	E1
Rational	----	----	1.582	----	----	2.325	----	----	3.423	E2
Rational	----	----	377.85	----	----	549.02	----	----	811.04	E3
Rational	----	----	3.624	----	----	5.323	----	----	7.838	E4
Rational	----	----	27.07	----	----	39.65	----	----	58.43	E5
Rational	----	----	0.260	----	----	0.383	----	----	0.563	A0
Rational	----	----	0.882	----	----	1.293	----	----	1.905	A1
Rational	----	----	0.751	----	----	1.104	----	----	1.625	A2
Rational	----	----	0.294	----	----	0.432	----	----	0.636	A3
Rational	----	----	0.363	----	----	0.536	----	----	0.788	A4
Rational	----	----	0.587	----	----	0.864	----	----	1.272	A5
Rational	----	----	0.703	----	----	1.031	----	----	1.519	A6
Rational	----	----	0.881	----	----	1.297	----	----	1.908	A7
Rational	----	----	0.587	----	----	0.864	----	----	1.272	A8
Rational	----	----	0.221	----	----	0.323	----	----	0.476	A9
Rational	----	----	0.703	----	----	1.031	----	----	1.519	A10

Hydrograph Summary Report

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to peak (min)	Volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Maximum storage (cuft)	Hydrograph description
1	Rational	24.16	1	12	26,097	---	----	----	E1
2	Rational	3.423	1	9	2,772	---	----	----	E2
3	Rational	811.04	1	29	2,116,820	---	----	----	E3
4	Rational	7.838	1	9	6,349	---	----	----	E4
5	Rational	58.43	1	12	63,106	---	----	----	E5
6	Rational	0.563	1	8	406	---	----	----	A0
7	Rational	1.905	1	11	1,886	---	----	----	A1
8	Rational	1.625	1	9	1,316	---	----	----	A2
9	Rational	0.636	1	7	401	---	----	----	A3
10	Rational	0.788	1	5	354	---	----	----	A4
11	Rational	1.272	1	7	801	---	----	----	A5
12	Rational	1.519	1	10	1,367	---	----	----	A6
13	Rational	1.908	1	7	1,202	---	----	----	A7
14	Rational	1.272	1	7	801	---	----	----	A8
15	Rational	0.476	1	11	472	---	----	----	A9
16	Rational	1.519	1	10	1,367	---	----	----	A10

Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

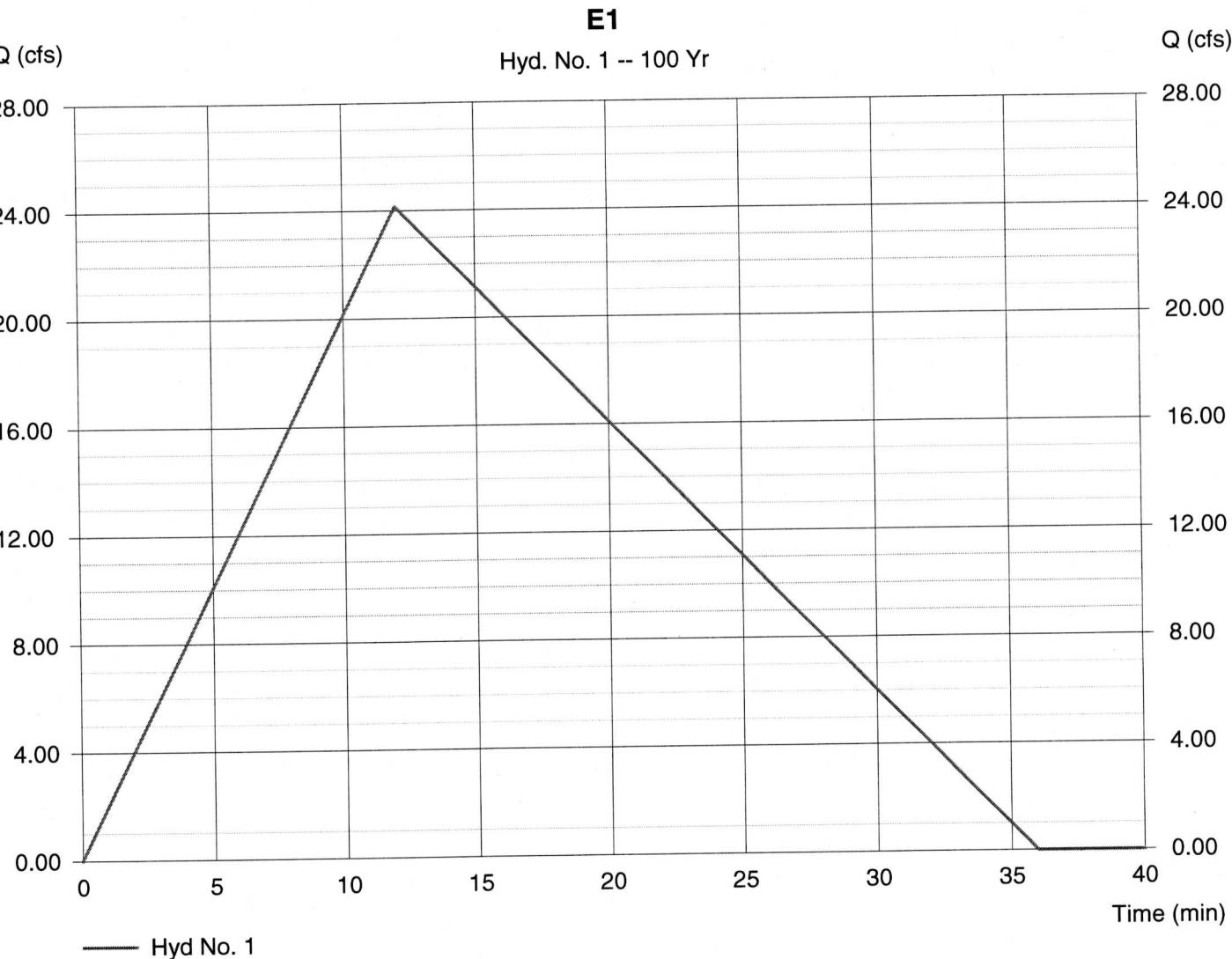
Hyd. No. 1

E1

Hydrograph type = Rational
Storm frequency = 100 yrs
Drainage area = 11.120 ac
Intensity = 5.300 in/hr
DF Curve = Spitsbergen.IDF

Peak discharge = 24.16 cfs
Time interval = 1 min
Runoff coeff. = 0.41
Tc by User = 12.00 min
Asc/Rec limb fact = 1/2

Hydrograph Volume = 26,097 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

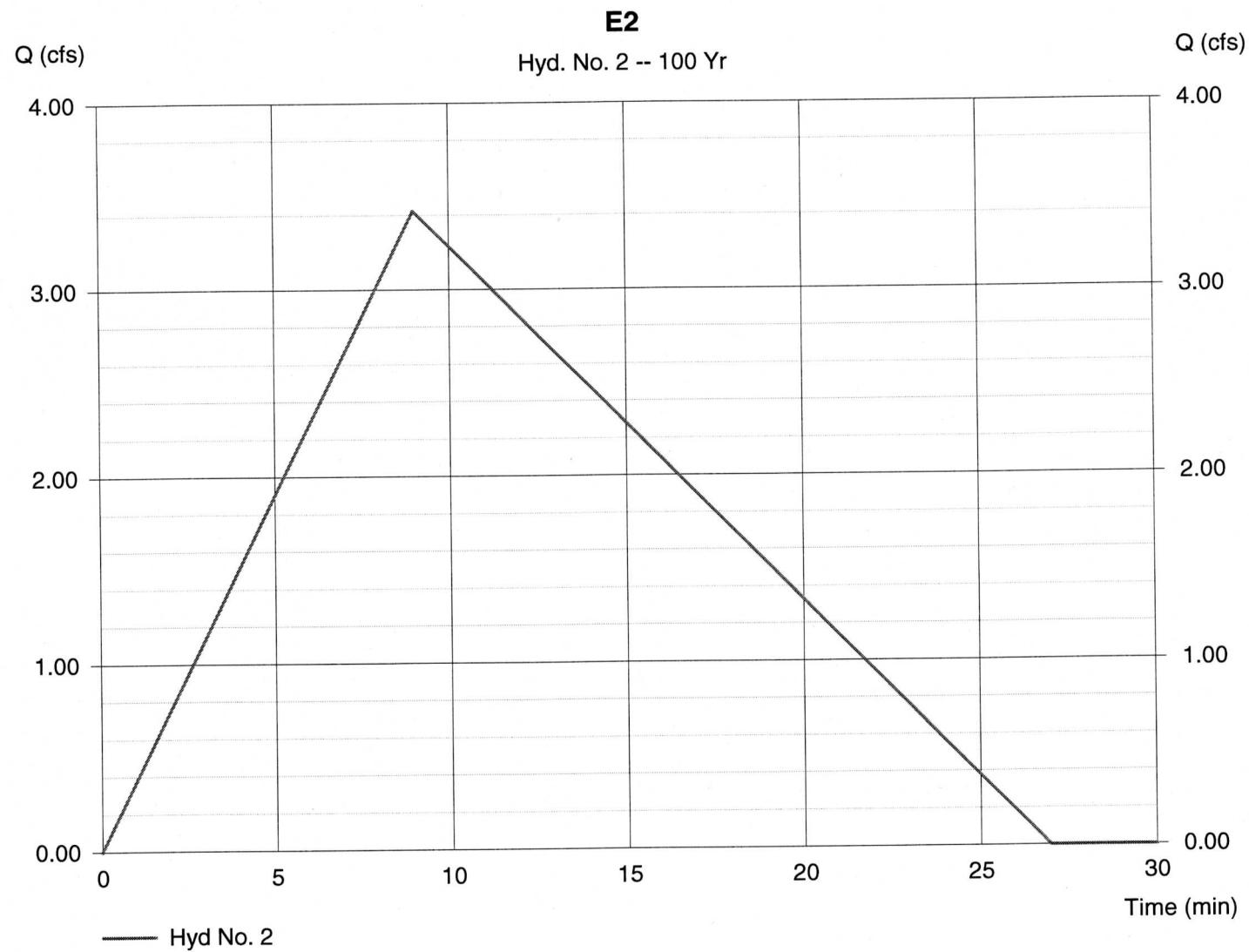
Hyd. No. 2

E2

Hydrograph type = Rational
 Storm frequency = 100 yrs
 Drainage area = 1.310 ac
 Intensity = 6.372 in/hr
 IDF Curve = Spitsbergen.IDF

Peak discharge = 3.423 cfs
 Time interval = 1 min
 Runoff coeff. = 0.41
 Tc by User = 9.00 min
 Asc/Rec limb fact = 1/2

Hydrograph Volume = 2,772 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

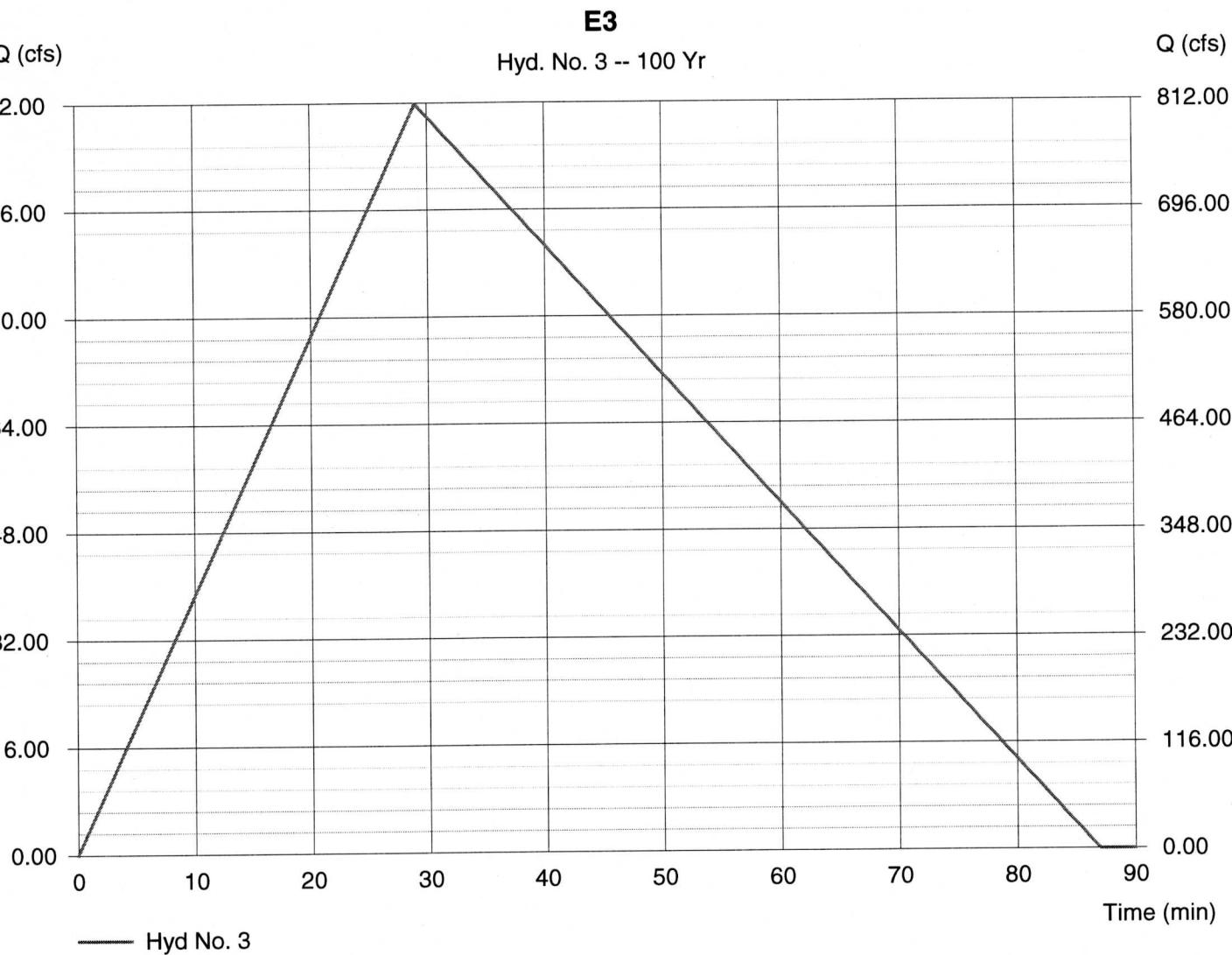
Hyd. No. 3

E3

Hydrograph type = Rational
Storm frequency = 100 yrs
Drainage area = 658.300 ac
Intensity = 3.005 in/hr
DF Curve = Spitsbergen.IDF

Peak discharge = 811.04 cfs
Time interval = 1 min
Runoff coeff. = 0.41
Tc by User = 29.00 min
Asc/Rec limb fact = 1/2

Hydrograph Volume = 2,116,820 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

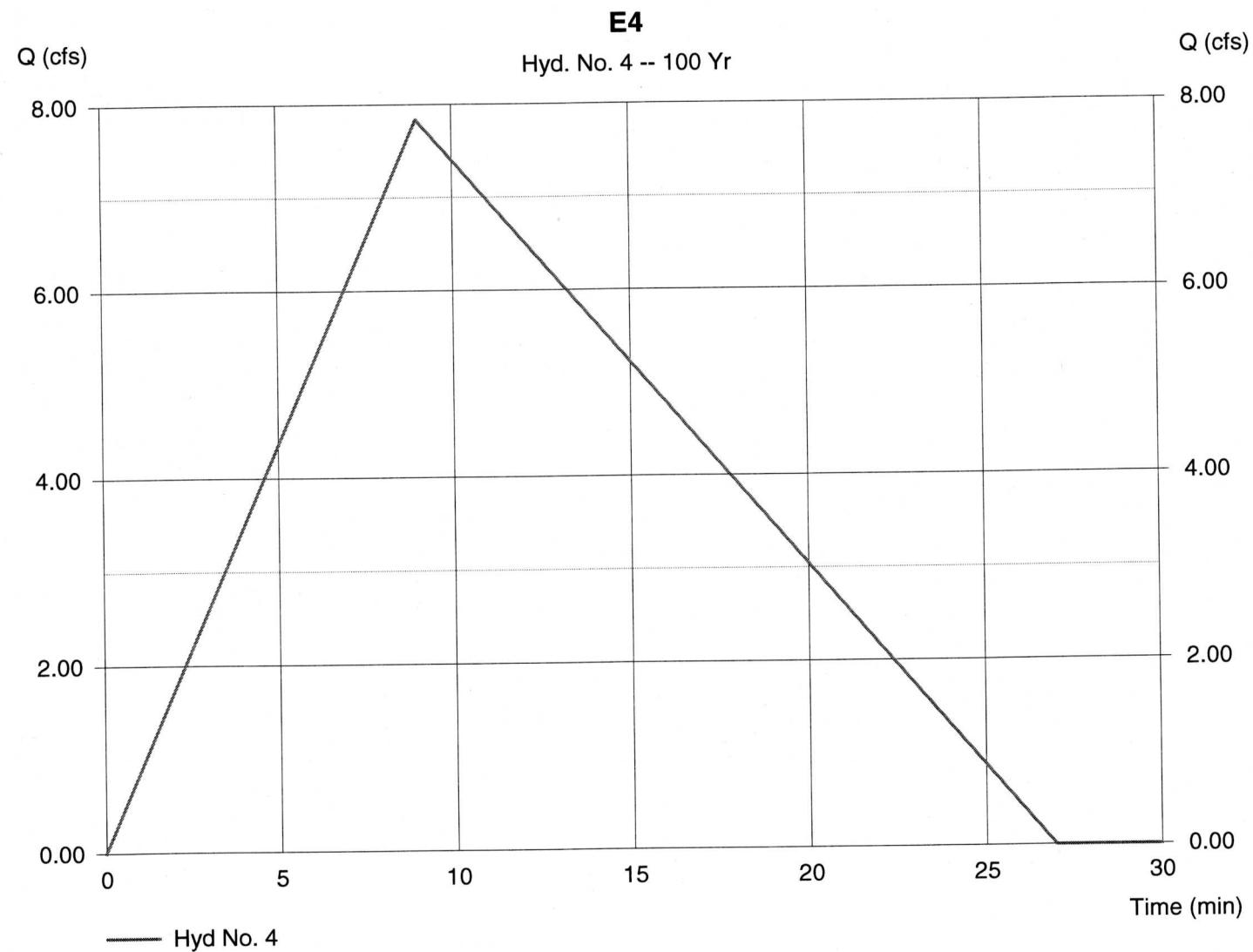
Hyd. No. 4

E4

Hydrograph type = Rational
 Storm frequency = 100 yrs
 Drainage area = 3.000 ac
 Intensity = 6.372 in/hr
 IDF Curve = Spitsbergen.IDF

Peak discharge = 7.838 cfs
 Time interval = 1 min
 Runoff coeff. = 0.41
 Tc by User = 9.00 min
 Asc/Rec limb fact = 1/2

Hydrograph Volume = 6,349 cuft



Hydrograph Plot

Hydraflow Hydrographs by InteliSolve

Tuesday, Mar 13 2007, 1:14 PM

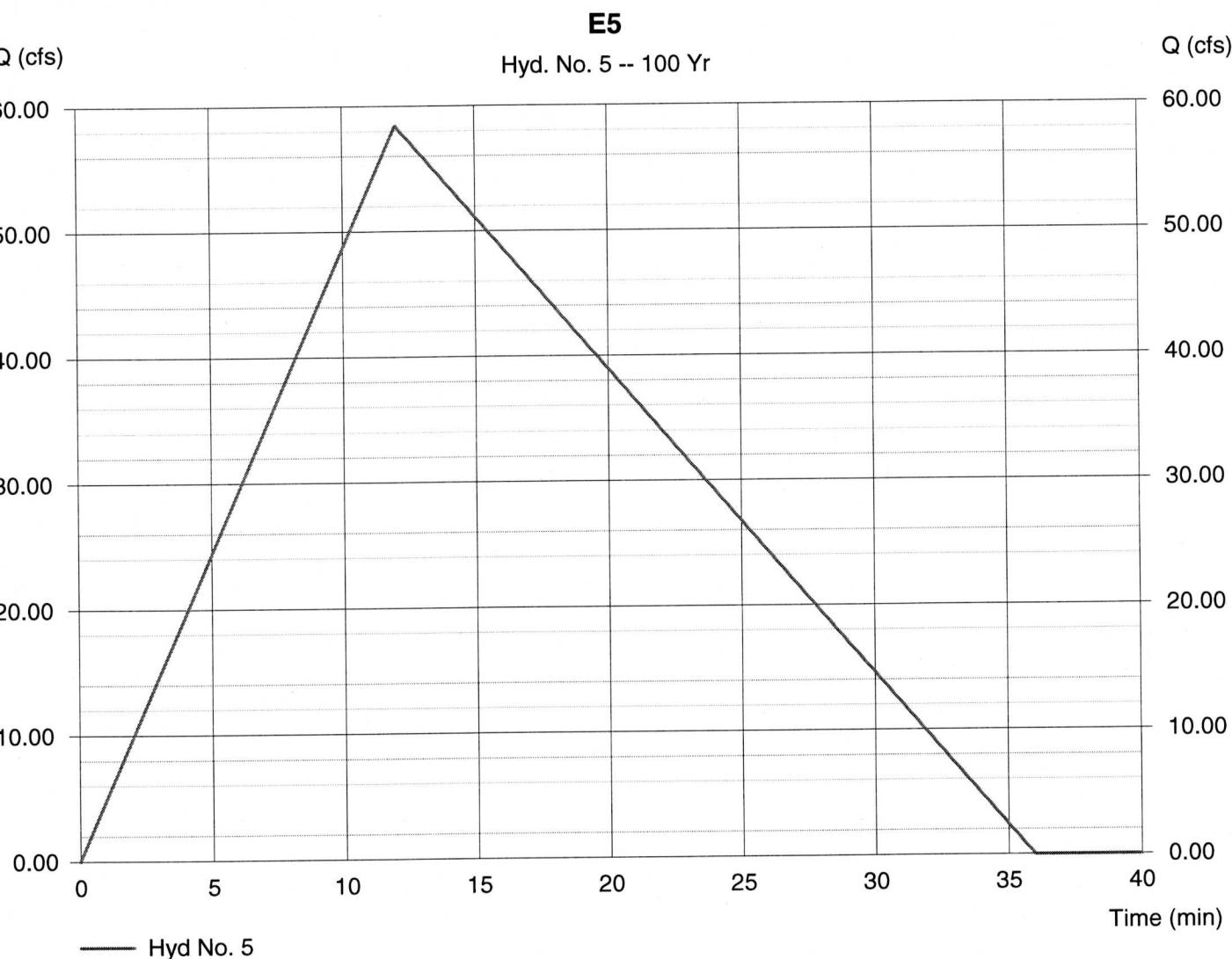
Hyd. No. 5

E5

Hydrograph type = Rational
Storm frequency = 100 yrs
Drainage area = 26.890 ac
Intensity = 5.300 in/hr
DF Curve = Spitsbergen.IDF

Peak discharge = 58.43 cfs
Time interval = 1 min
Runoff coeff. = 0.41
Tc by User = 12.00 min
Asc/Rec limb fact = 1/2

Hydrograph Volume = 63,106 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

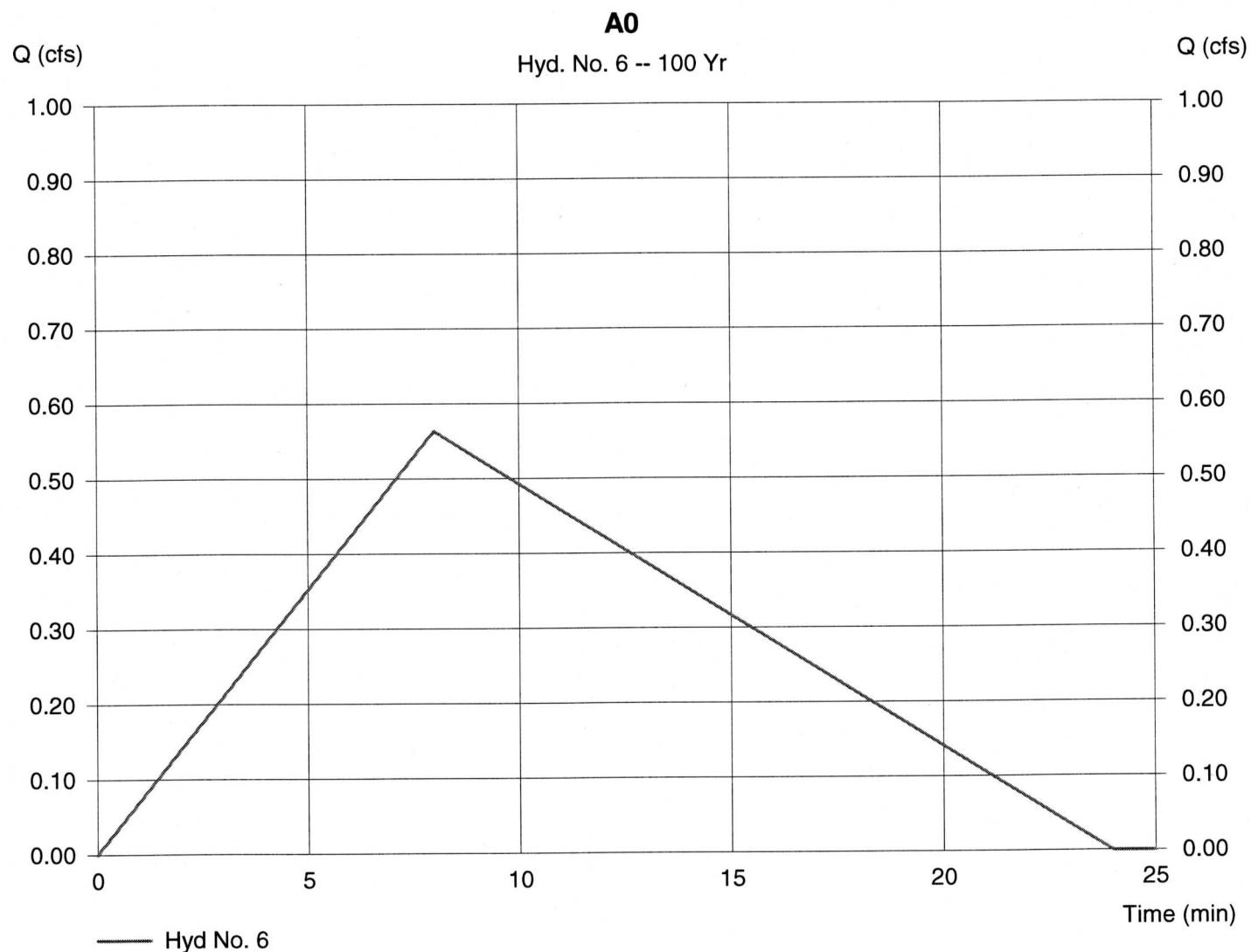
Hyd. No. 6

A0

Hydrograph type = Rational
 Storm frequency = 100 yrs
 Drainage area = 0.100 ac
 Intensity = 6.870 in/hr
 IDF Curve = Spitsbergen.IDF

Peak discharge = 0.563 cfs
 Time interval = 1 min
 Runoff coeff. = 0.82
 Tc by User = 8.00 min
 Asc/Rec limb fact = 1/2

Hydrograph Volume = 406 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

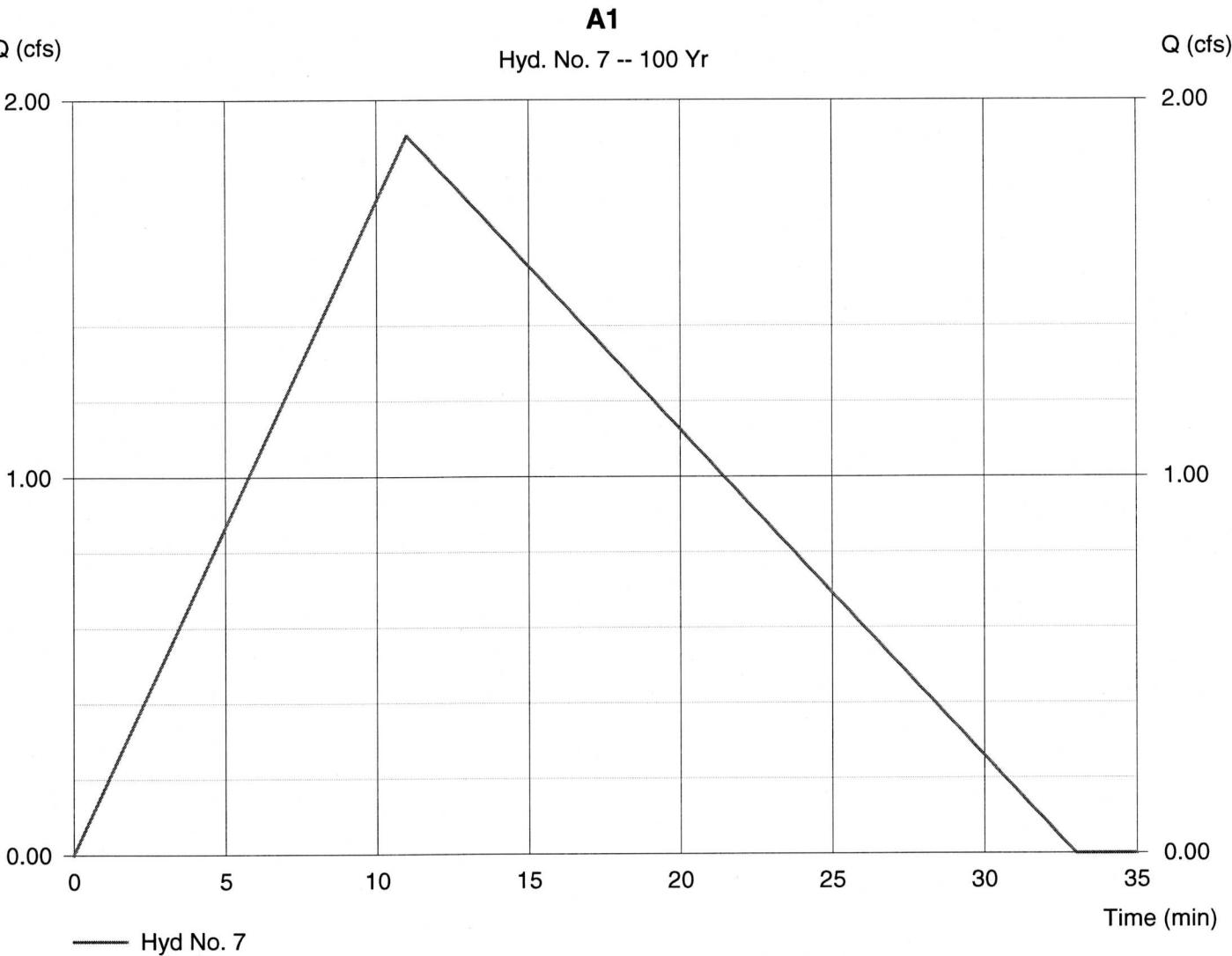
Hyd. No. 7

A1

Hydrograph type = Rational
Storm frequency = 100 yrs
Drainage area = 0.400 ac
Intensity = 5.604 in/hr
DF Curve = Spitsbergen.IDF

Peak discharge = 1.905 cfs
Time interval = 1 min
Runoff coeff. = 0.85
Tc by User = 11.00 min
Asc/Rec limb fact = 1/2

Hydrograph Volume = 1,886 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

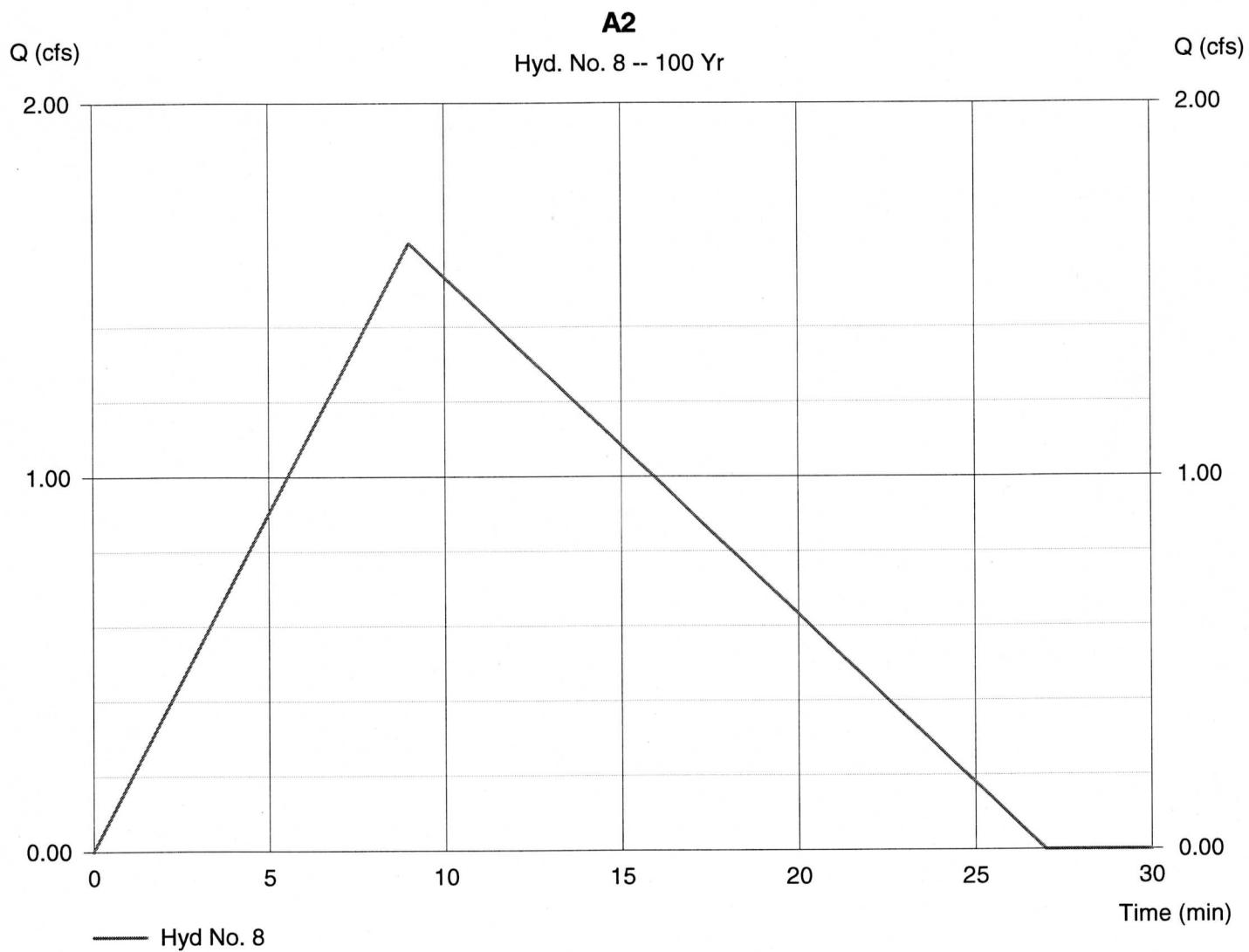
Hyd. No. 8

A2

Hydrograph type = Rational
 Storm frequency = 100 yrs
 Drainage area = 0.300 ac
 Intensity = 6.372 in/hr
 IDF Curve = Spitsbergen.IDF

Peak discharge = 1.625 cfs
 Time interval = 1 min
 Runoff coeff. = 0.85
 Tc by User = 9.00 min
 Asc/Rec limb fact = 1/2

Hydrograph Volume = 1,316 cuft



Hydrograph Plot

Hydroflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

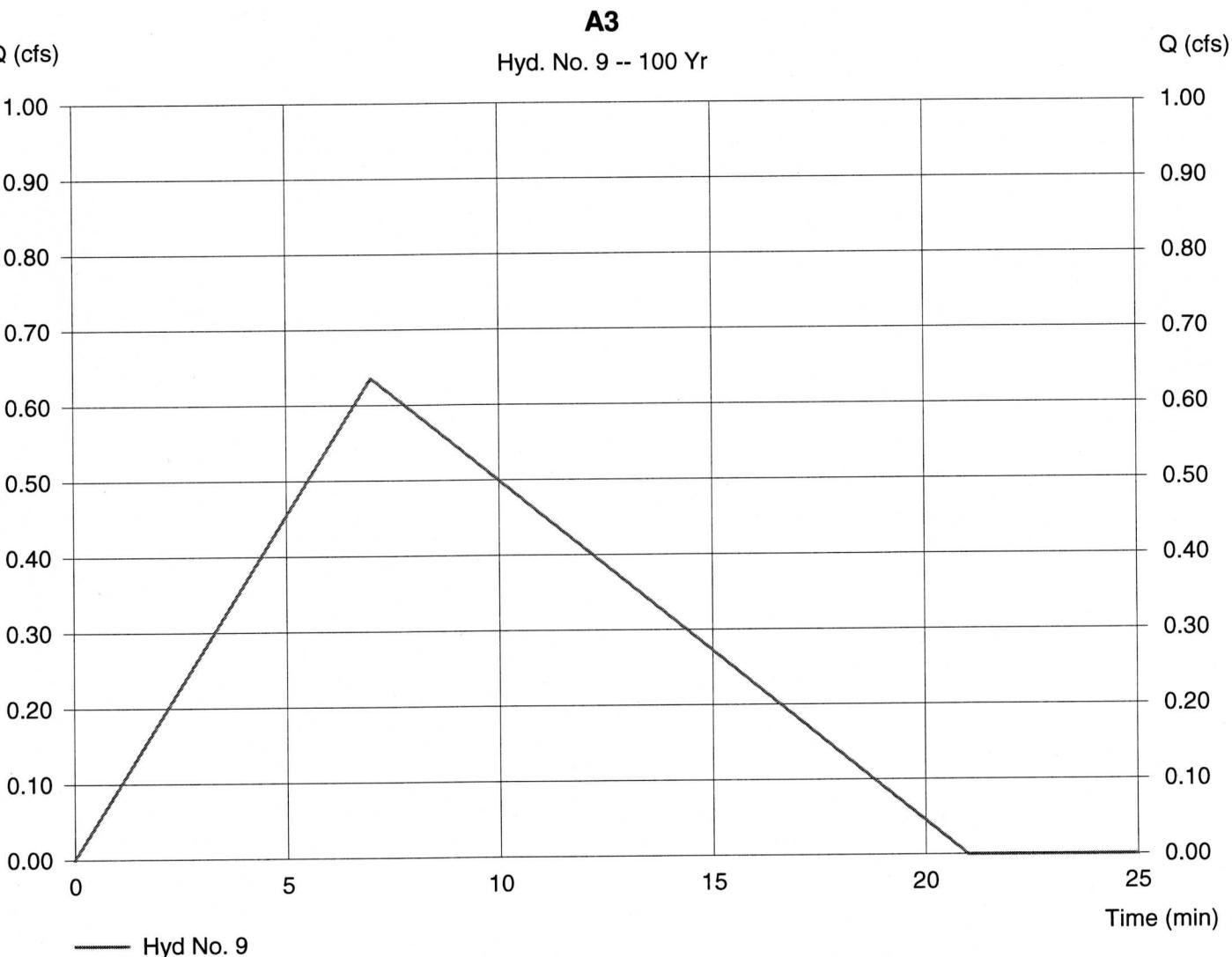
Hyd. No. 9

A3

Hydrograph type = Rational
Storm frequency = 100 yrs
Drainage area = 0.100 ac
Intensity = 7.481 in/hr
DF Curve = Spitsbergen.IDF

Peak discharge = 0.636 cfs
Time interval = 1 min
Runoff coeff. = 0.85
Tc by User = 7.00 min
Asc/Rec limb fact = 1/2

Hydrograph Volume = 401 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

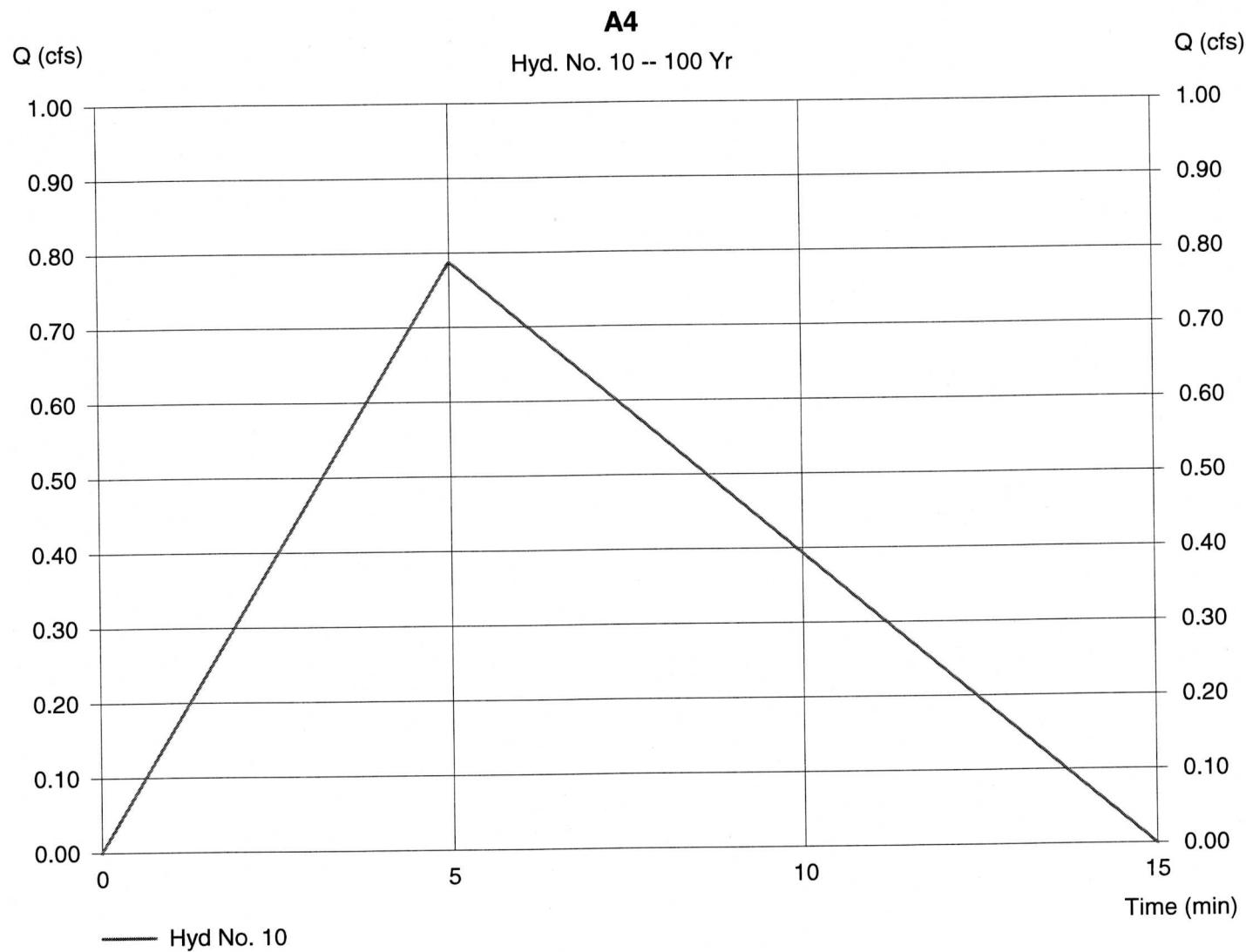
Hyd. No. 10

A4

Hydrograph type = Rational
 Storm frequency = 100 yrs
 Drainage area = 0.100 ac
 Intensity = 9.266 in/hr
 IDF Curve = Spitsbergen.IDF

Peak discharge = 0.788 cfs
 Time interval = 1 min
 Runoff coeff. = 0.85
 Tc by User = 5.00 min
 Asc/Rec limb fact = 1/2

Hydrograph Volume = 354 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

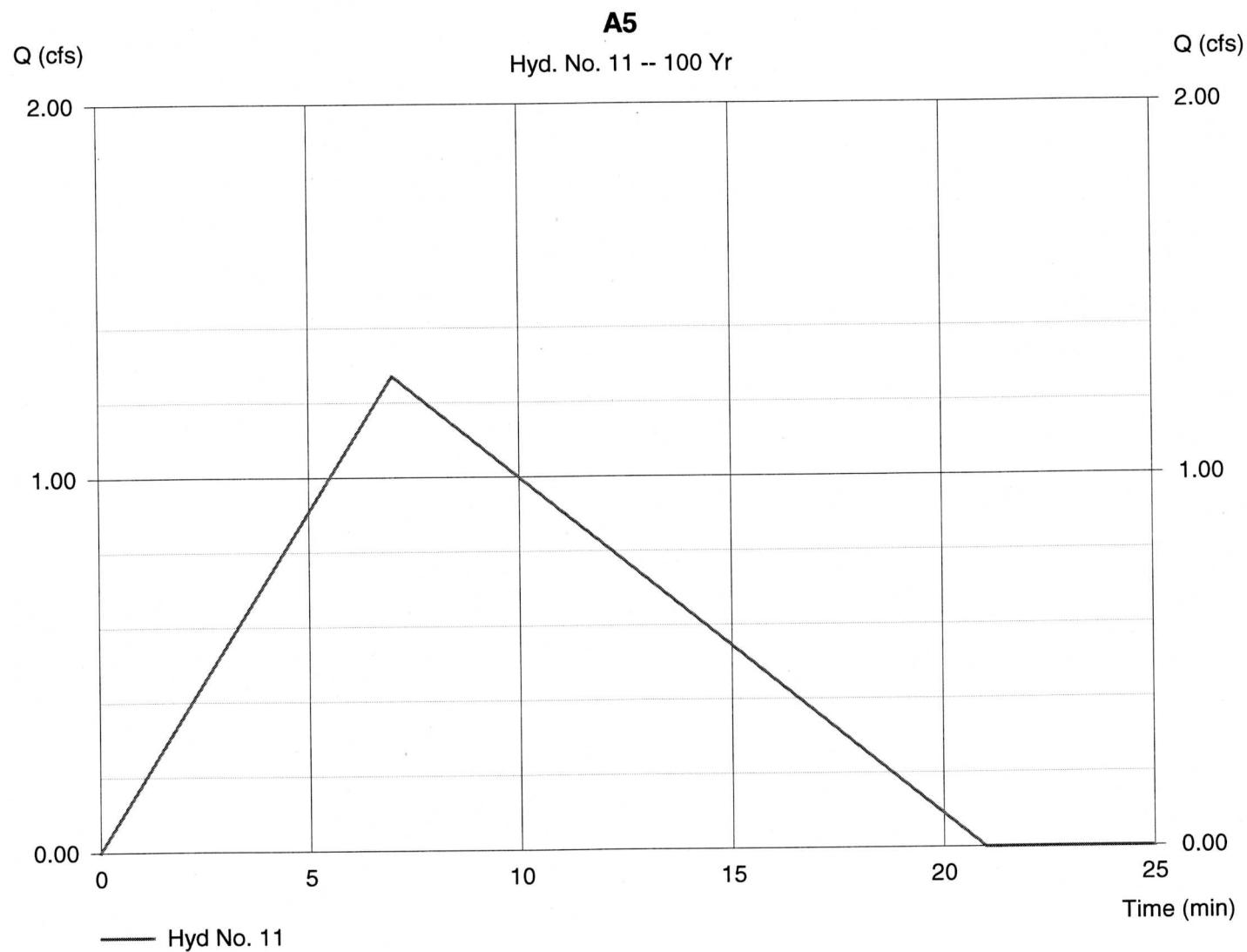
Hyd. No. 11

A5

Hydrograph type = Rational
 Storm frequency = 100 yrs
 Drainage area = 0.200 ac
 Intensity = 7.481 in/hr
 IDF Curve = Spitsbergen.IDF

Peak discharge = 1.272 cfs
 Time interval = 1 min
 Runoff coeff. = 0.85
 Tc by User = 7.00 min
 Asc/Rec limb fact = 1/2

Hydrograph Volume = 801 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

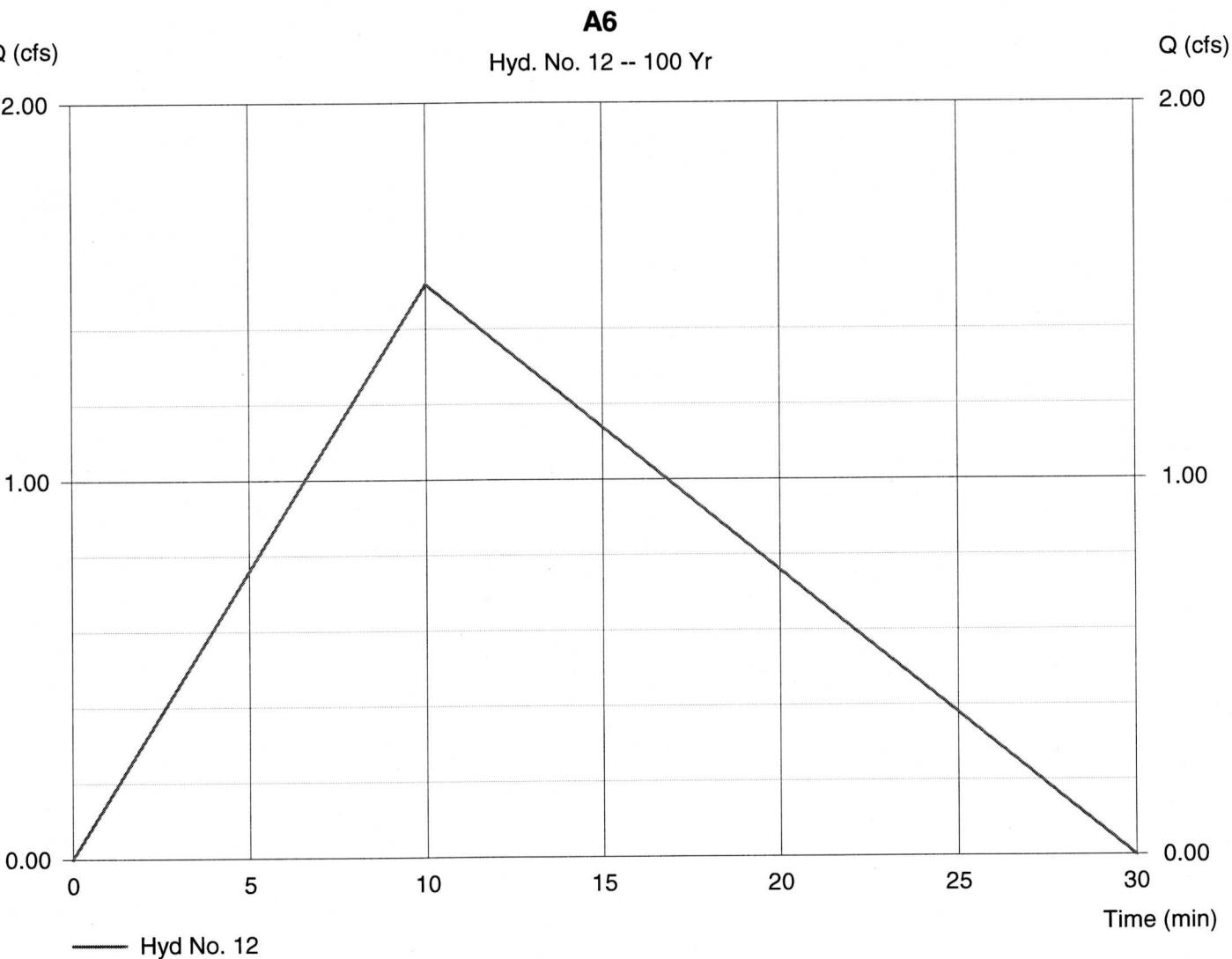
Hyd. No. 12

A6

Hydrograph type = Rational
Storm frequency = 100 yrs
Drainage area = 0.300 ac
Intensity = 5.957 in/hr
DF Curve = Spitsbergen.IDF

Peak discharge = 1.519 cfs
Time interval = 1 min
Runoff coeff. = 0.85
Tc by User = 10.00 min
Asc/Rec limb fact = 1/2

Hydrograph Volume = 1,367 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

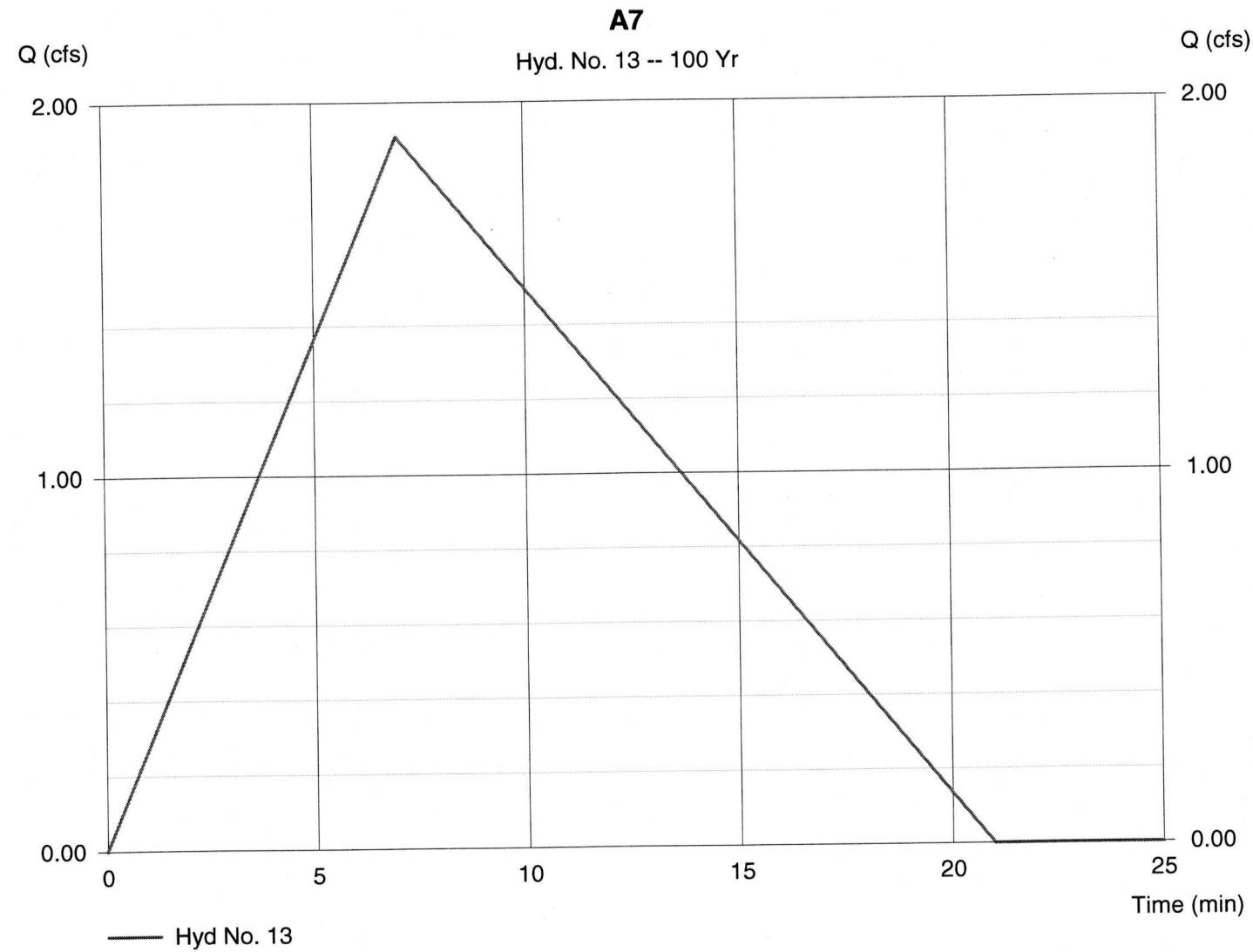
Hyd. No. 13

A7

Hydrograph type = Rational
 Storm frequency = 100 yrs
 Drainage area = 0.300 ac
 Intensity = 7.481 in/hr
 IDF Curve = Spitsbergen.IDF

Peak discharge = 1.908 cfs
 Time interval = 1 min
 Runoff coeff. = 0.85
 Tc by User = 7.00 min
 Asc/Rec limb fact = 1/2

Hydrograph Volume = 1,202 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

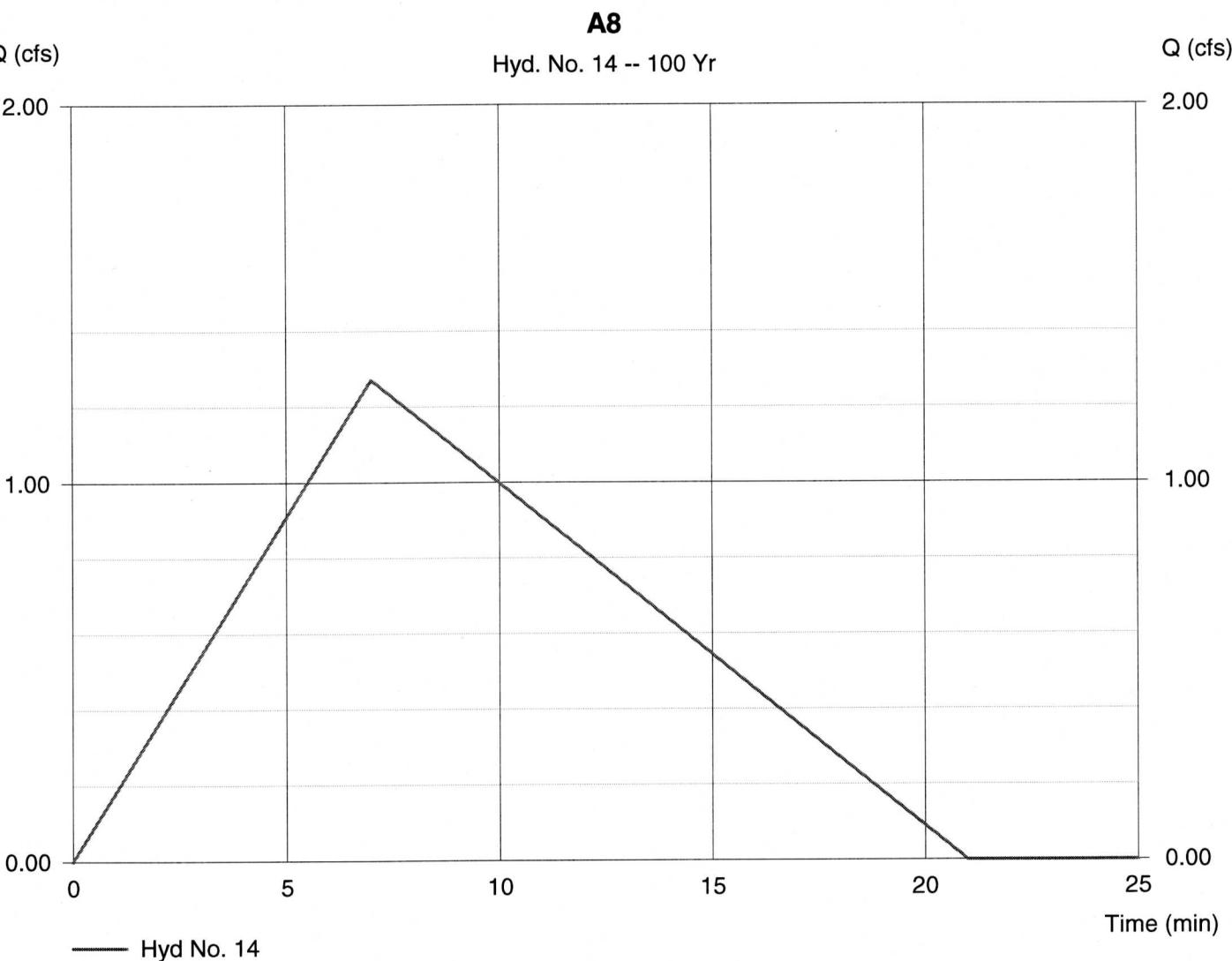
Hyd. No. 14

A8

Hydrograph type = Rational
Storm frequency = 100 yrs
Drainage area = 0.200 ac
Intensity = 7.481 in/hr
DF Curve = Spitsbergen.IDF

Peak discharge = 1.272 cfs
Time interval = 1 min
Runoff coeff. = 0.85
Tc by User = 7.00 min
Asc/Rec limb fact = 1/2

Hydrograph Volume = 801 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

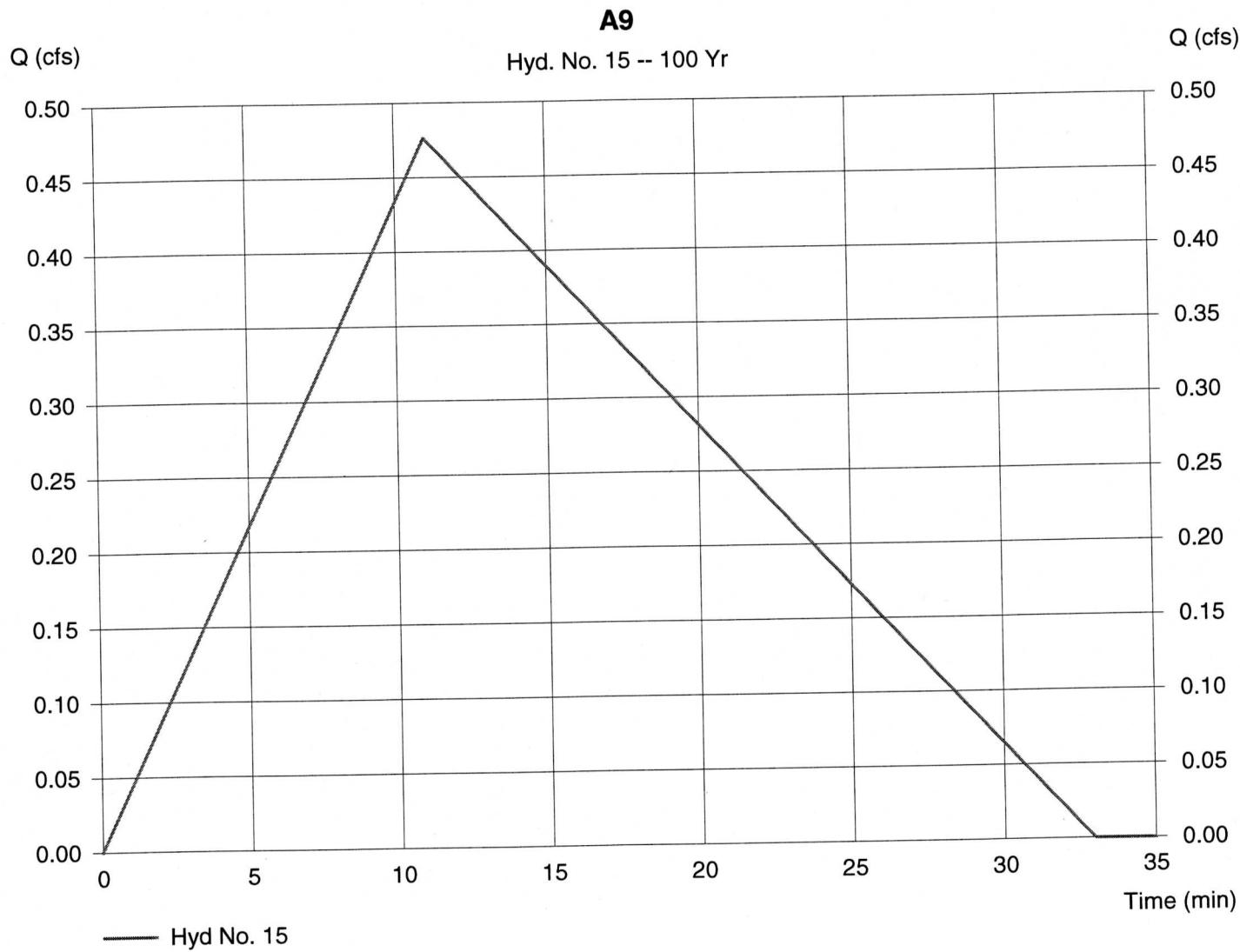
Hyd. No. 15

A9

Hydrograph type = Rational
 Storm frequency = 100 yrs
 Drainage area = 0.100 ac
 Intensity = 5.604 in/hr
 IDF Curve = Spitsbergen.IDF

Peak discharge = 0.476 cfs
 Time interval = 1 min
 Runoff coeff. = 0.85
 Tc by User = 11.00 min
 Asc/Rec limb fact = 1/2

Hydrograph Volume = 472 cuft



Hydrograph Plot

Hydraflow Hydrographs by Intelisolve

Tuesday, Mar 13 2007, 1:14 PM

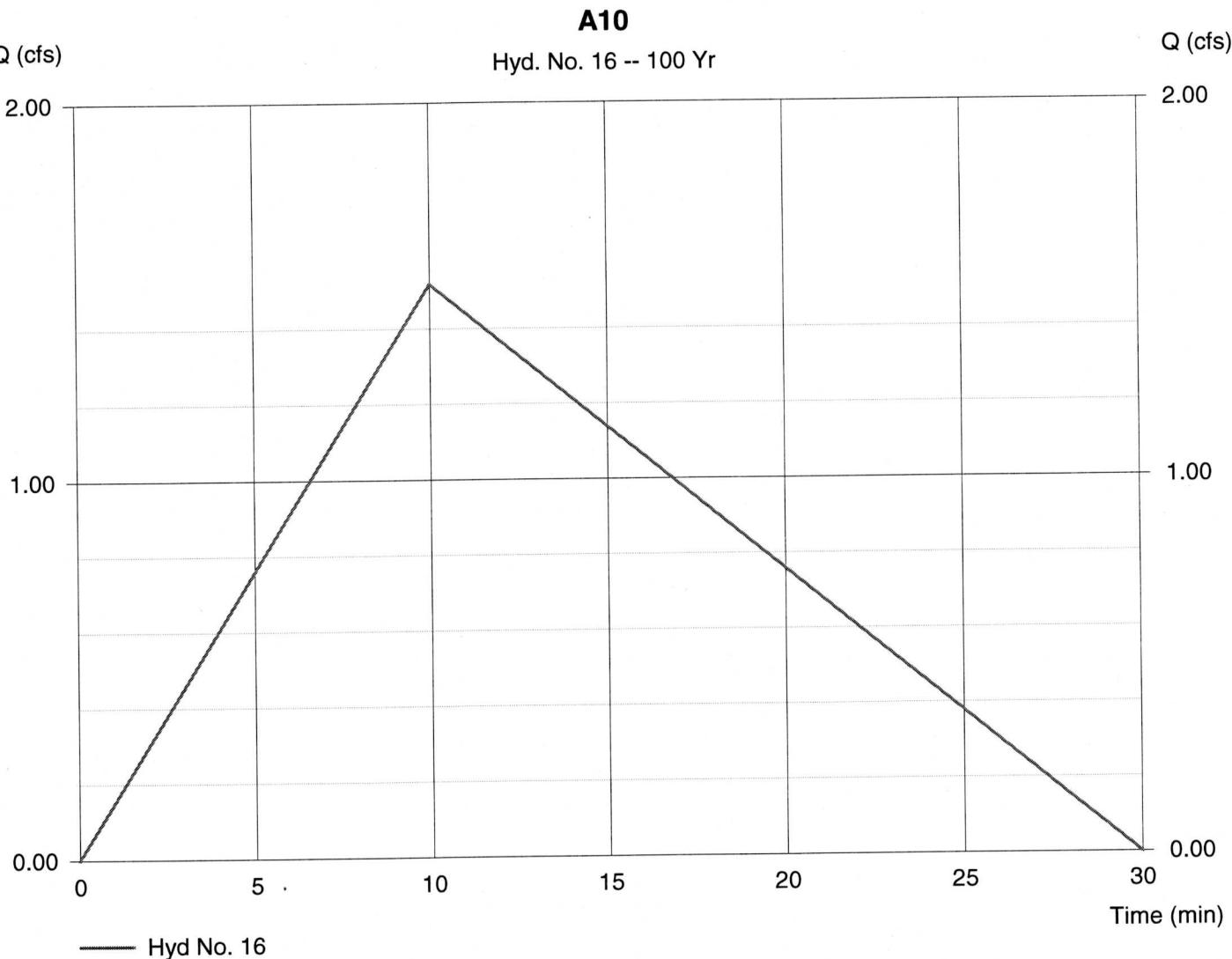
Hyd. No. 16

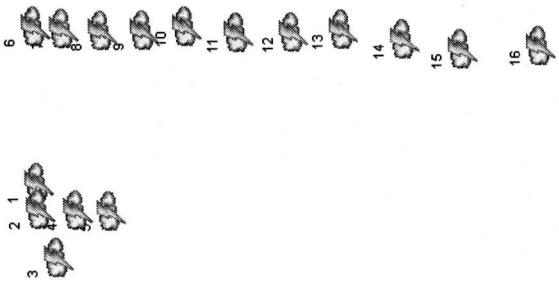
A10

Hydrograph type = Rational
Storm frequency = 100 yrs
Drainage area = 0.300 ac
Intensity = 5.957 in/hr
DF Curve = Spitsbergen.IDF

Peak discharge = 1.519 cfs
Time interval = 1 min
Runoff coeff. = 0.85
Tc by User = 10.00 min
Asc/Rec limb fact = 1/2

Hydrograph Volume = 1,367 cuft





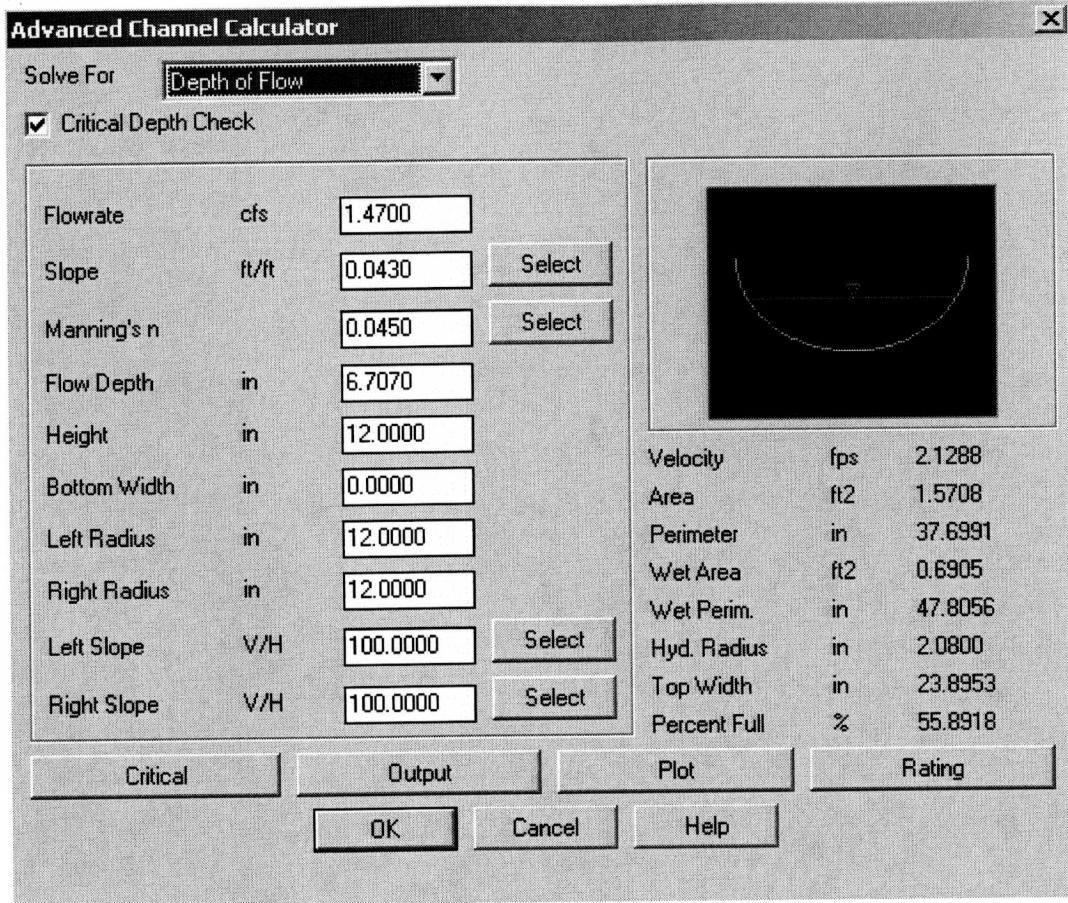
Legend

<u>Hyd.</u>	<u>Origin</u>	<u>Description</u>
1	Rational	E1
2	Rational	E2
3	Rational	E3
4	Rational	E4
5	Rational	E5
6	Rational	A0
7	Rational	A1
8	Rational	A2
9	Rational	A3
10	Rational	A4
11	Rational	A5
12	Rational	A6
13	Rational	A7
14	Rational	A8
15	Rational	A9
16	Rational	A10

Hydroflow Hydrographs Model

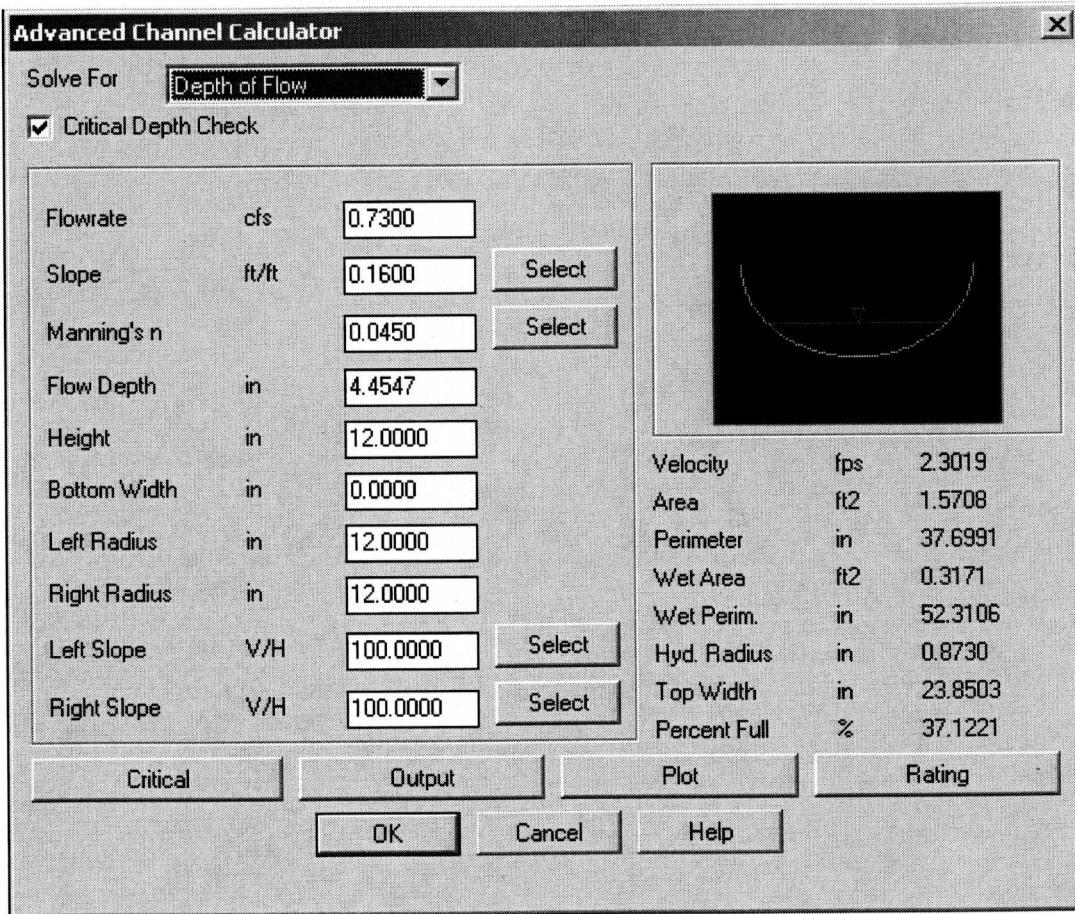
Project: Spitsbergen.gpw

Tuesday, Mar 13 2007, 1:13 PM



NE Project No. 103-214.1

Vegetated Swale calculation for proposed pavement area A10.



NE Project No. 103-214.1

Vegetated Swale calculation for proposed pavement area A4.

Advanced Channel Calculator

Solve For: Depth of Flow

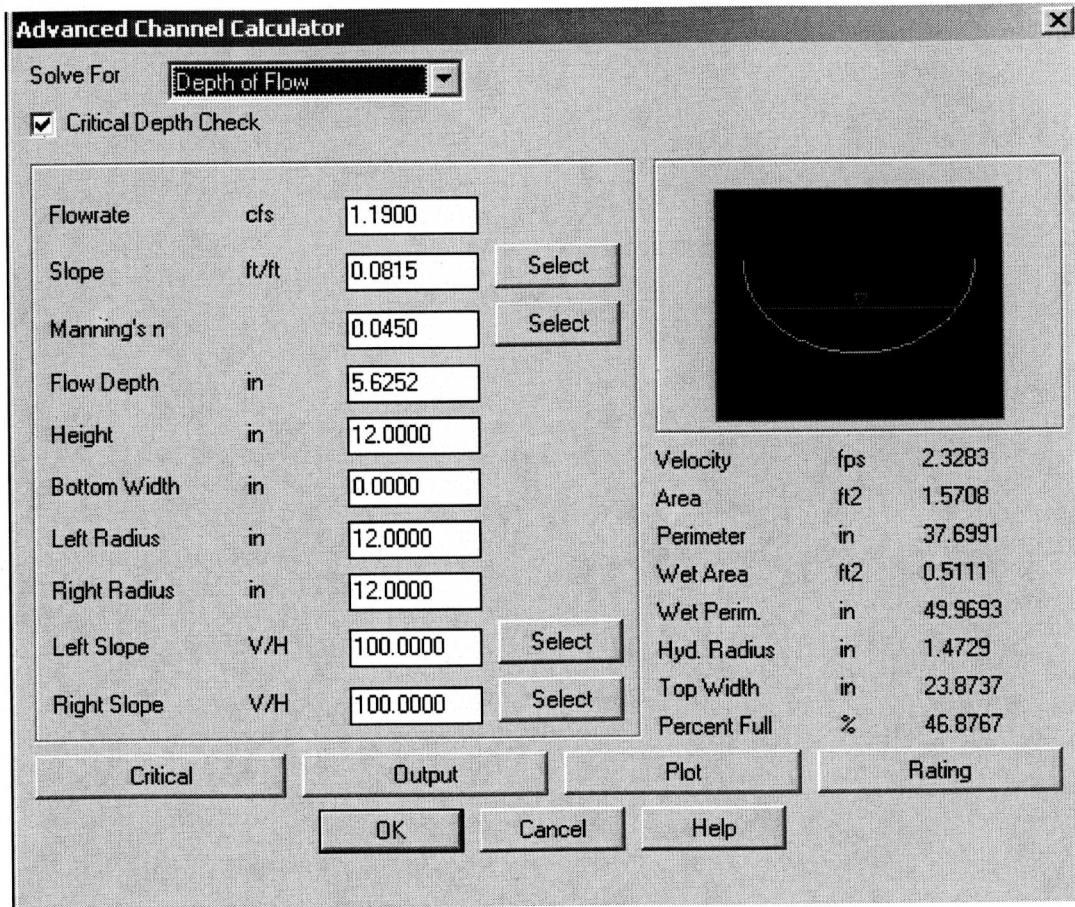
Critical Depth Check

Flowrate	cfs	0.4600	<input type="button" value="Select"/>
Slope	ft/ft	0.0260	<input type="button" value="Select"/>
Manning's n		0.0450	<input type="button" value="Select"/>
Flow Depth	in	5.0213	
Height	in	12.0000	
Bottom Width	in	0.0000	
Left Radius	in	12.0000	
Right Radius	in	12.0000	
Left Slope	V/H	100.0000	<input type="button" value="Select"/>
Right Slope	V/H	100.0000	<input type="button" value="Select"/>

Velocity	fps	1.1192
Area	ft ²	1.5708
Perimeter	in	37.6991
Wet Area	ft ²	0.4110
Wet Perim.	in	51.1773
Hyd. Radius	in	1.1564
Top Width	in	23.8616
Percent Full	%	41.8438

NE Project No. 103-214.1

Vegetated Swale calculation for proposed pavement area A9.



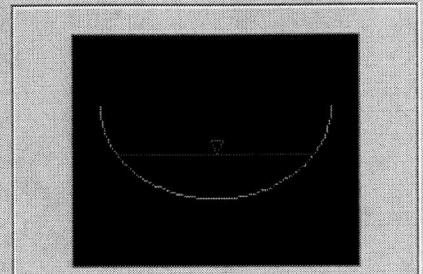
NE Project No. 103-214.1

Vegetated Swale calculation for proposed pavement area A8.

Advanced Channel Calculator

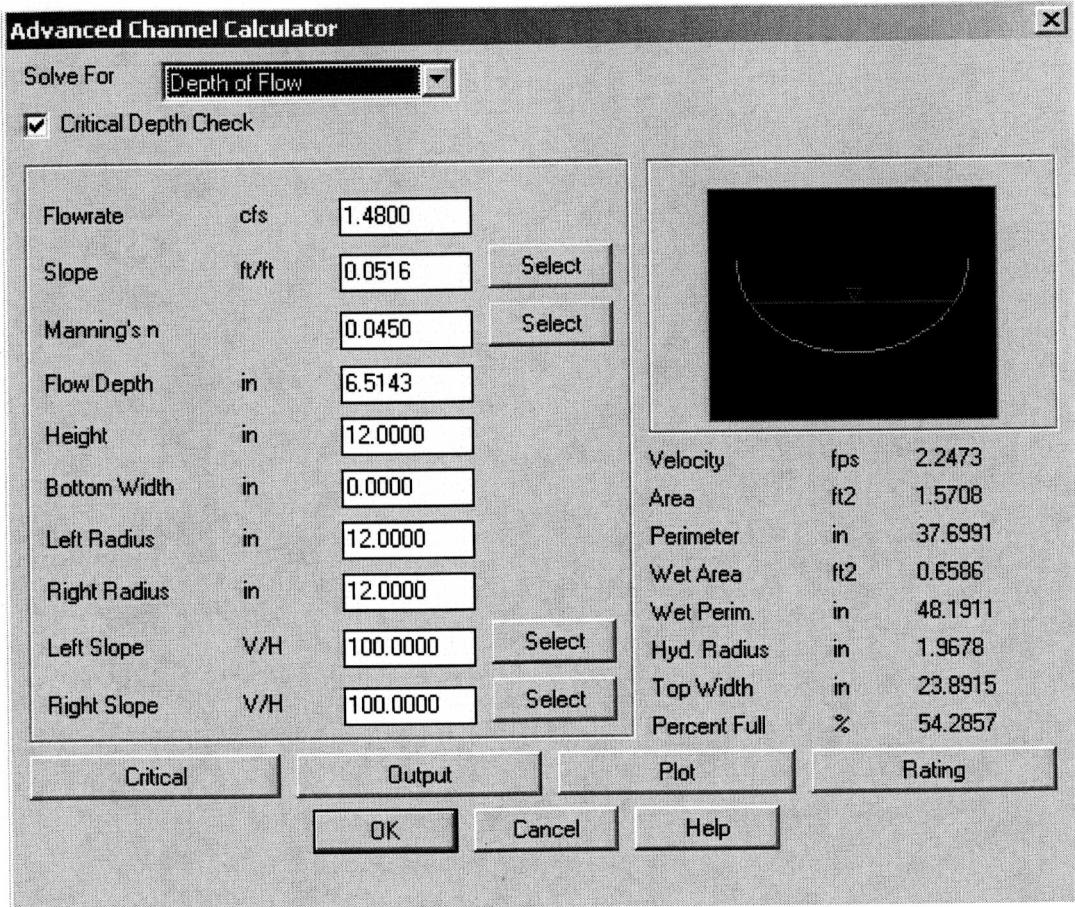
Solve For

Depth of Flow

 Critical Depth CheckFlowrate cfs Slope ft/ft Manning's n Flow Depth in Height in Bottom Width in Left Radius in Right Radius in Left Slope V/H Right Slope V/H Velocity fps Area ft² Perimeter in Wet Area ft² Wet Perim. in Hyd. Radius in Top Width in Percent Full %

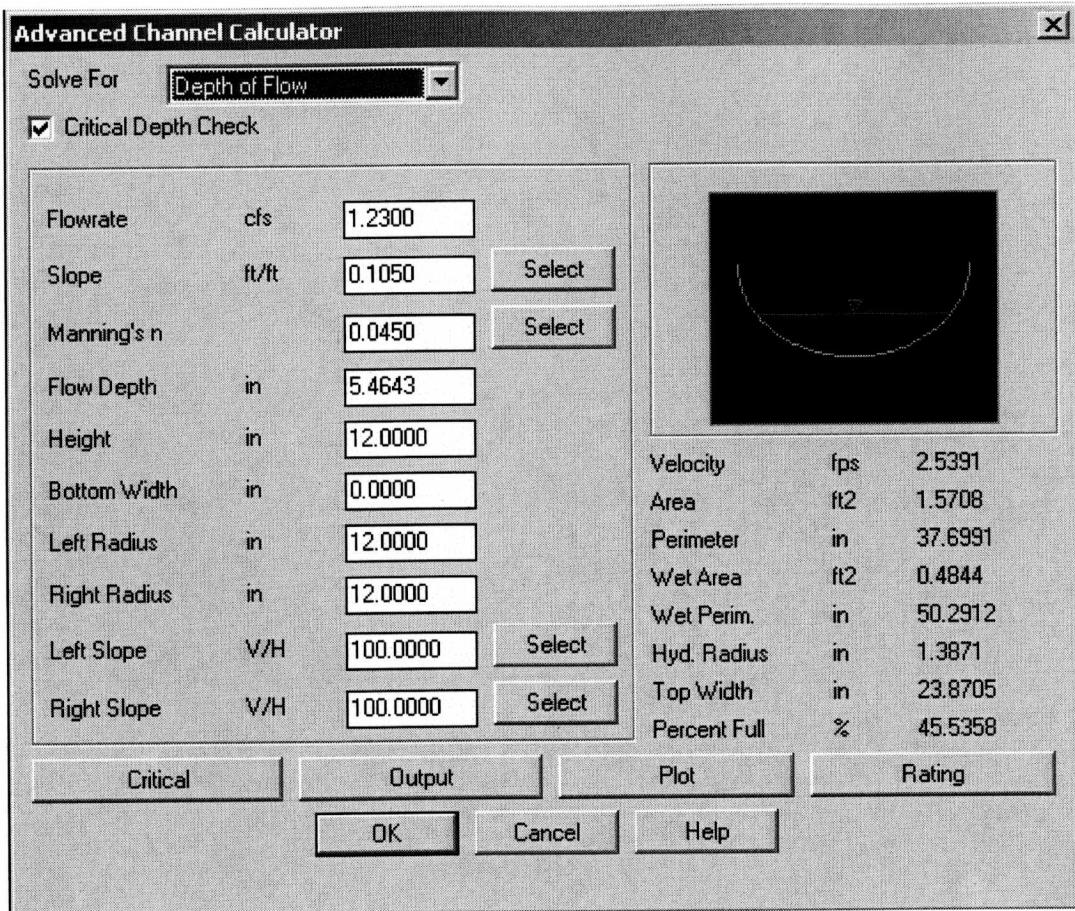
NE Project No. 103-214.1

Vegetated Swale calculation for proposed pavement area A7.



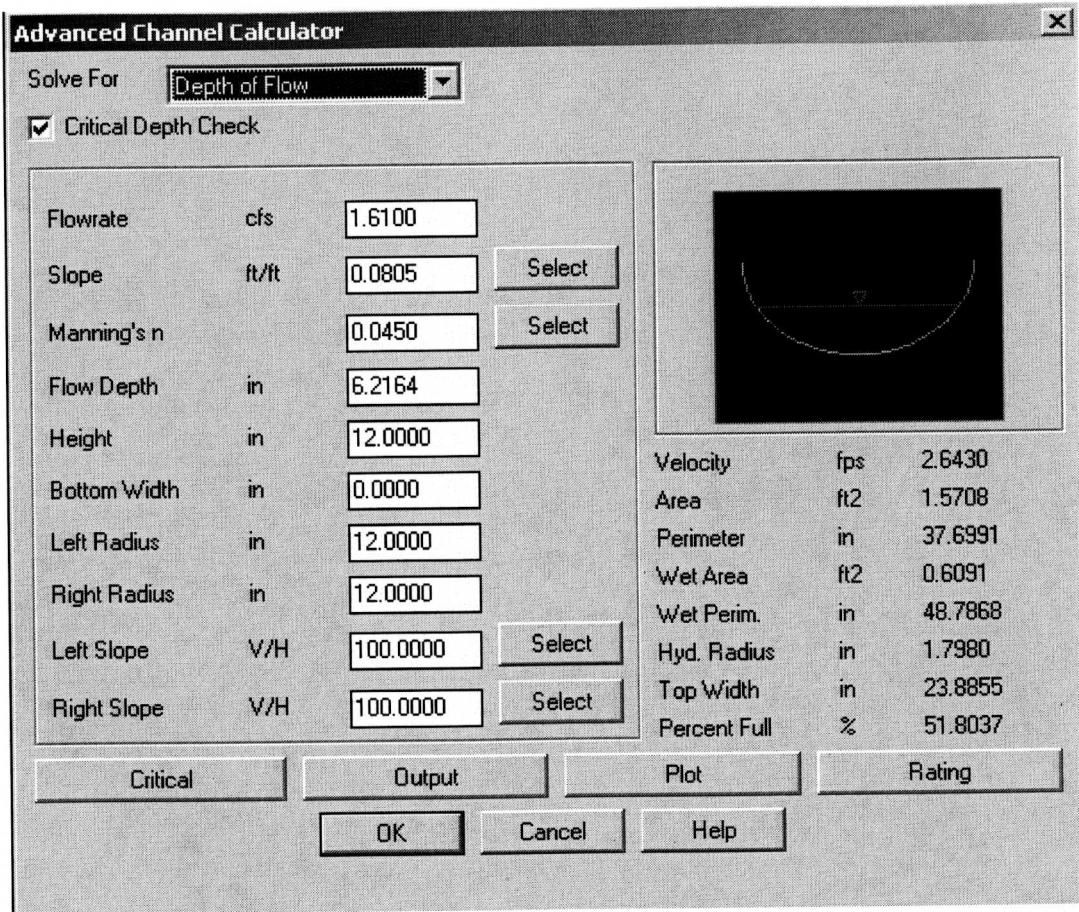
NE Project No. 103-214.1

Vegetated Swale calculation for proposed pavement area A6.



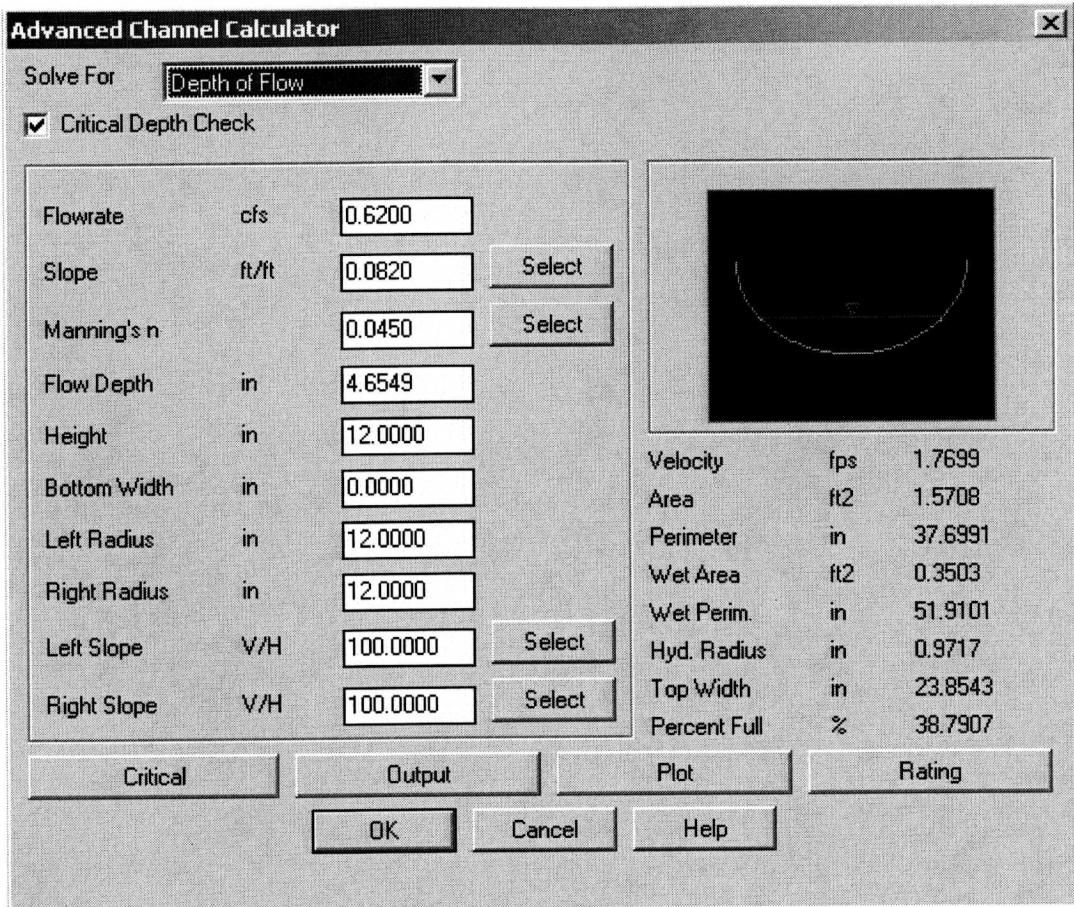
NE Project No. 103-214.1

Vegetated Swale calculation for proposed pavement area A5.



NE Project No. 103-214.1

Vegetated Swale calculation for proposed pavement area A2.



NE Project No. 103-214.1

Vegetated Swale calculation for proposed pavement area A3.

Advanced Channel Calculator

Solve For **Depth of Flow**

Critical Depth Check

Flowrate	cfs	1.8000	<input type="button" value="Select"/>
Slope	ft/ft	0.0400	<input type="button" value="Select"/>
Manning's n		0.0450	<input type="button" value="Select"/>
Flow Depth	in	7.2996	
Height	in	12.0000	
Bottom Width	in	0.0000	
Left Radius	in	12.0000	
Right Radius	in	12.0000	
Left Slope	V/H	100.0000	<input type="button" value="Select"/>
Right Slope	V/H	100.0000	<input type="button" value="Select"/>

Velocity	fps	2.2817
Area	ft ²	1.5708
Perimeter	in	37.6991
Wet Area	ft ²	0.7889
Wet Perim.	in	46.6203
Hyd. Radius	in	2.4367
Top Width	in	23.9072
Percent Full	%	60.8302

NE Project No. 103-214.1

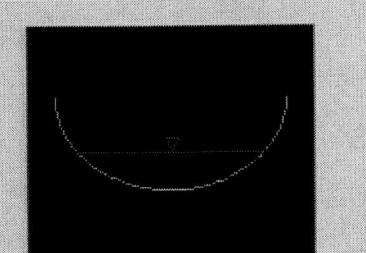
Vegetated Swale calculation for proposed pavement area A1.

Advanced Channel Calculator

Solve For **Depth of Flow**

Critical Depth Check

Flowrate	cfs	0.5800	<input type="button" value="Select"/>
Slope	ft/ft	0.0500	<input type="button" value="Select"/>
Manning's n		0.0450	<input type="button" value="Select"/>
Flow Depth	in	4.8885	
Height	in	12.0000	
Bottom Width	in	0.0000	
Left Radius	in	12.0000	
Right Radius	in	12.0000	
Left Slope	V/H	100.0000	<input type="button" value="Select"/>
Right Slope	V/H	100.0000	<input type="button" value="Select"/>



Velocity	fps	1.4910
Area	ft ²	1.5708
Perimeter	in	37.6991
Wet Area	ft ²	0.3890
Wet Perim.	in	51.4429
Hyd. Radius	in	1.0889
Top Width	in	23.8590
Percent Full	%	40.7371

NE Project No. 103-214.1

Vegetated Swale calculation for proposed pavement area A0.

Table 3-1
RUNOFF COEFFICIENTS FOR URBAN AREAS

NRCS Elements	Land Use	County Elements	Runoff Coefficient "C"			
			% IMPER.	A	B	Soil Type
Undisturbed Natural Terrain (Natural)	Permanent Open Space	0*	0.20	0.25	0.30	0.35
Low Density Residential (LDR)	Residential, 1.0 DU/A or less	10	0.27	0.32	0.36	0.41
Low Density Residential (LDR)	Residential, 2.0 DU/A or less	20	0.34	0.38	0.42	0.46
Low Density Residential (LDR)	Residential, 2.9 DU/A or less	25	0.38	0.41	0.45	0.49
Medium Density Residential (MDR)	Residential, 4.3 DU/A or less	30	0.41	0.45	0.48	0.52
Medium Density Residential (MDR)	Residential, 7.3 DU/A or less	40	0.48	0.51	0.54	0.57
Medium Density Residential (MDR)	Residential, 10.9 DU/A or less	45	0.52	0.54	0.57	0.60
Medium Density Residential (MDR)	Residential, 14.5 DU/A or less	50	0.55	0.58	0.60	0.63
High Density Residential (HDR)	Residential, 24.0 DU/A or less	65	0.66	0.67	0.69	0.71
High Density Residential (HDR)	Residential, 43.0 DU/A or less	80	0.76	0.77	0.78	0.79
Commercial/Industrial (N. Com)	Neighborhood Commercial	80	0.76	0.77	0.78	0.79
Commercial/Industrial (G. Com)	General Commercial	85	0.80	0.80	0.81	0.82
Commercial/Industrial (O.P. Com)	Office Professional/Commercial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (Limited I.)	Limited Industrial	90	0.83	0.84	0.84	0.85
Commercial/Industrial (General I.)	General Industrial	95	0.87	0.87	0.87	0.87

*The values associated with 0% impervious may be used for direct calculation of the runoff coefficient as described in Section 3.1.2 (representing the pervious runoff coefficient, C_p , for the soil type), or for areas that will remain undisturbed in perpetuity. Justification must be given that the area will remain natural forever (e.g., the area is located in Cleveland National Forest).

DU/A = dwelling units per acre

NRCS = National Resources Conservation Service

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

**MAXIMUM OVERLAND FLOW LENGTH (L_M)
& INITIAL TIME OF CONCENTRATION (T_i)**

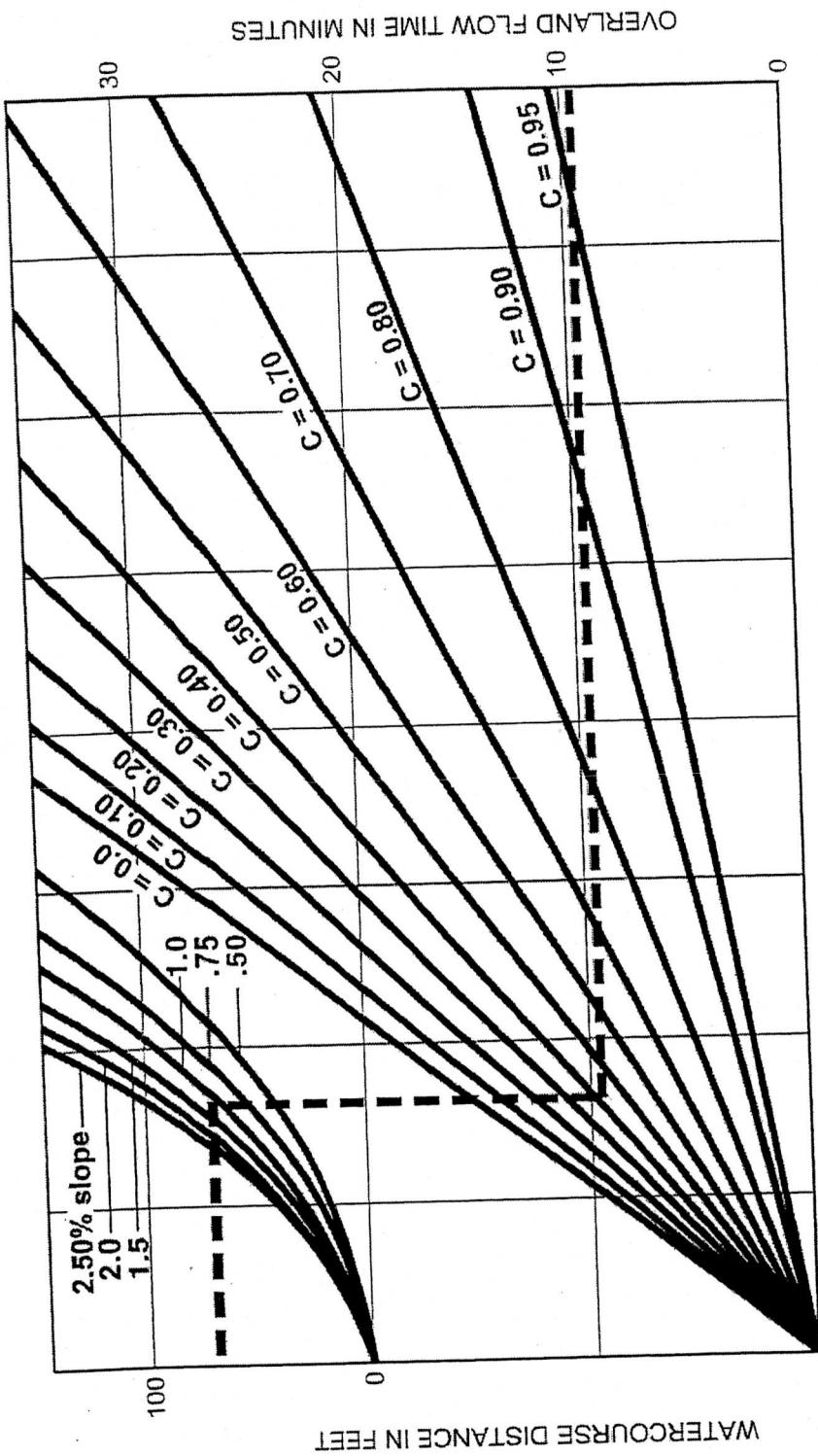
Element*	DU/ Acre	.5%		1%		2%		3%		5%		10%	
		L_M	T_i										
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description

3-3

FIGURE

Rational Formula - Overland Time of Flow Nomograph

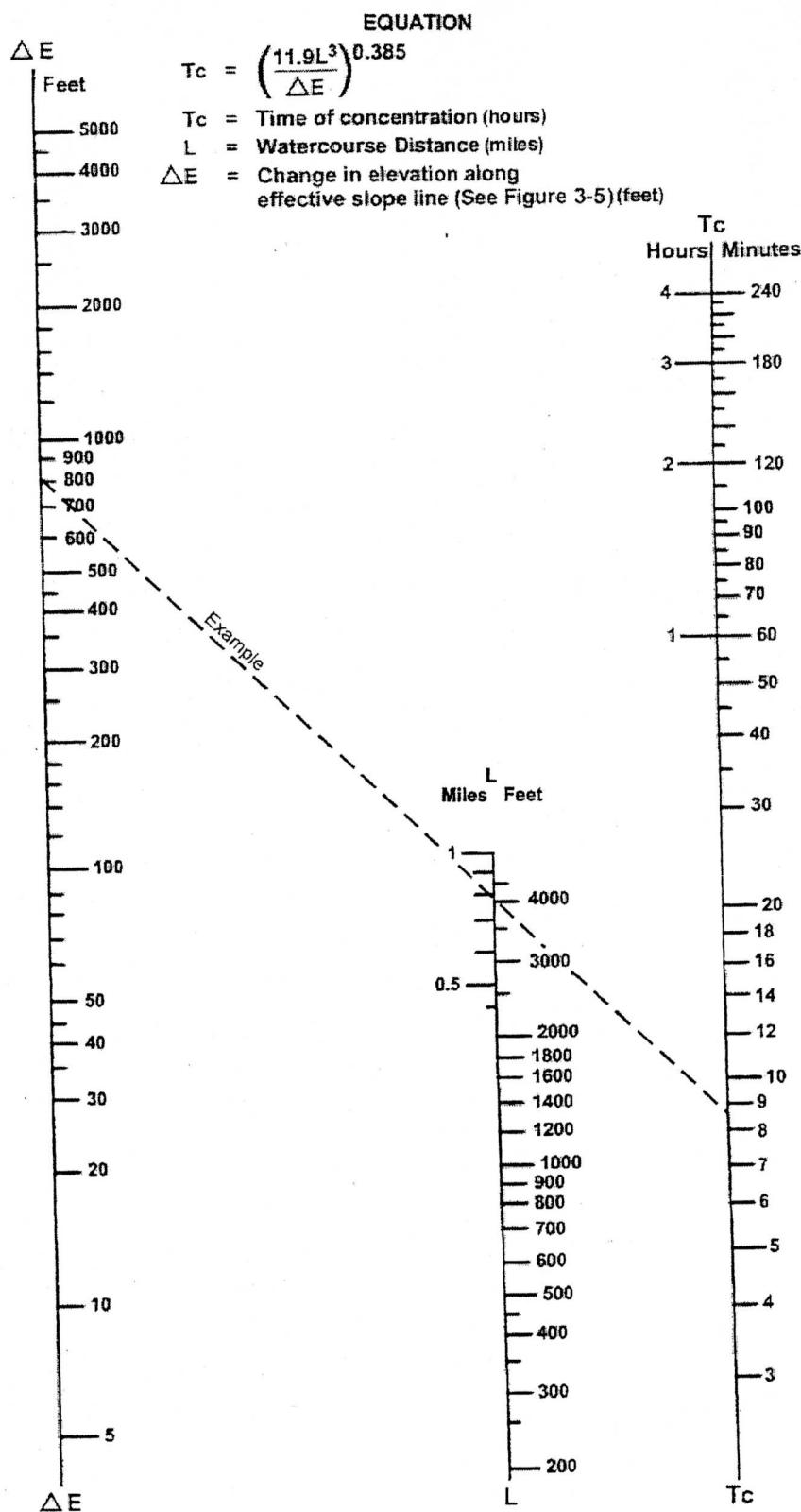


EXAMPLE:

Given: Watercourse Distance (D) = 70 Feet
 Slope (s) = 1.3 %
 Runoff Coefficient (C) = 0.41
 Overland Flow Time (T) = 9.5 Minutes

SOURCE: Airport Drainage, Federal Aviation Administration, 1965

$$T = \frac{1.8 (1.1-C) \sqrt{D}}{3\sqrt{s}}$$



SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE

Nomograph for Determination of
Time of Concentration (T_c) or Travel Time (T_t) for Natural Watersheds

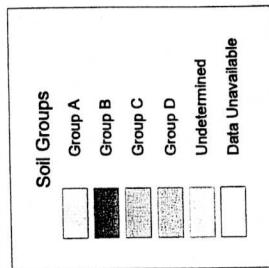
3-4

County of San Diego Hydrology Manual



Soil Hydrologic Groups

Legend



We Have San Diego Coverage
San Diego GIS
San Diego County Water Conservation District



San Diego County Water Conservation District

THIS MAP IS PROVIDED WITHOUT WARRANTY OF ANY KIND, EITHER
EXPLICIT OR IMPLICATED, BUT IS PROVIDED TO THE USER AS IS.
THE MAP IS PROVIDED "AS IS" AND WITHOUT WARRANTY OF ANY KIND,
EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED
WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.
Copyright 2002, San Diego County Water Conservation District.

The product may contain information which has been reproduced with
written permission of SANDAG.

The product may contain information which have been reproduced with
written permission by Thomas Brooks Maps.

3 Miles



32°30' 32°45' 32°45' 32°30'
117.30' 117.15' 117.00' 116.85' 116.70' 116.55' 116.45' 116.30' 116.15'
Orange County Riverside County Imperial County Mexico
33°30' 33°15' 33°00' 32°45'

